OUTLINES OF BOTANY,

INCLUDING

A GENERAL HISTORY OF THE VEGETABLE KINGDOM,

IN WHICH

PLANTS ARE ARRANGED ACCORDING TO THE SYSTEM OF NATURAL AFFINITIES.

BY

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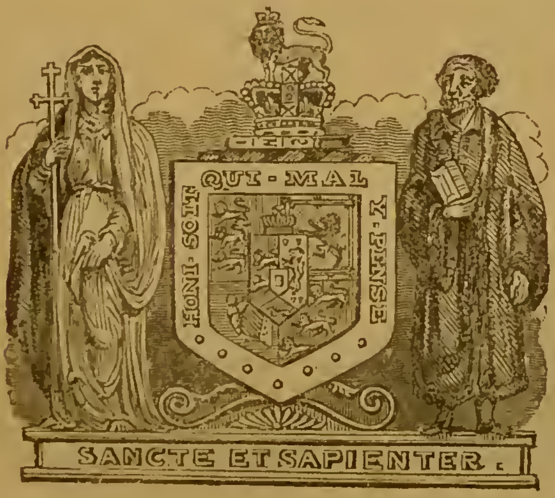

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GENERAL OUTLINE

OF

SUBJECTIVE BOTANY.

ADVERTISEMENT.

These "Outlines of Botany" contain the heads of the Subjective Course of Lectures annually delivered by the author in King's College, London. Indeed, the first two chapters have been but little altered, since they were given as parts of an introductory address. For the views then detailed being still retained, no attempt has been made to repeat similar ideas in different words. This will explain, and may perhaps excuse, their didactic tone, as well as the half sententious style, that purposely prevails throughout the work.

Being intended as a practical guide, and chiefly designed for the use of students, the preceptive form has been adopted as the most simple and advantageous mode of communicating elementary knowledge; for controversial statements bewilder the beginner; and, as some points are unsettled in every science, it is the duty of a guide, when doubts arise, to indicate the course to be pursued; as the tyro is less likely to err when led by experienced authority, than when, distracted by debateable doctrines, he is abandoned to his own unaided discretion. This method, however, necessarily precludes an extended discussion of many curious and important problems, which, in an argumentative treatise, would deservedly occupy attention. But although here unnoticed, their authors must not consider that the works alluded to have been either over-

looked or underprized. From the perusal of all, much pleasure and information have been gained; and from most, some facts have been gathered, which hereafter may be, perhaps, made use of, even when the speculations they were intended to support, cannot be introduced. Though forced to be thus far exclusive, the author is most anxious to declare, that he does not at any time venture to advance his judgment as a criterion of the correctness of the doctrines he adopts, or of the unsoundness of those that he rejects. It was essential to his scheme that some selection should be made, and for the present one, which results from much patient consideration, he willingly holds himself responsible. Not, however, as being pledged to the defence, rather to the correction, of any known errors that may have been admitted, or any unknown, which the future advances of philosophy may shew; but as believing it to afford a fair, though brief conspectus of subjective botany, in its present state.

Such a summary, it is thought, cannot be otherwise than useful to students, for there are few questions they more frequently ask, than "what books shall we read? In what course shall they be studied?" and there are few to which it is more difficult to give a short and satisfactory answer. For science is so constantly progressive; and botany especially, of all the natural sciences, has lately advanced, and is still advancing, with such almost inconceivable rapidity, that there is no one work or series of works which can be referred to as containing a full or sufficient abstract of the present state of knowledge. But, in order to march at all in the van of science, references must be made to many volumes, and additions and corrections must be drawn from many collateral sources of information. From these it is the duty of the lecturer to cull, and it is this ready engrafting of discoveries, as they are made, which gives one of its chief advantages to oral over written instruction.

Therefore, at the conclusion of the last session, while engaged in the preparation of a Syllabus, it seemed to the author

that an opportunity had occurred of giving, in some sort, an answer to the questions above proposed, by referring, under the several successive heads of lectures, to the books or chapters in which the several respective subjects have been most satisfactorily treated.

But, besides their overwhelming number, many of the references being to monographs published only in the Philosophical Transactions of learned societies, or to essays scattered through various British and foreign scientific journals, some of which it would be difficult, and others impossible, for students to procure; and furthermore, much of the most valuable information being locked up in works too costly for general purchase, or too voluminous for general perusal, it soon became evident that such could not be the answer which it was fitting the student should receive.

Hence, in addition to the bare references to many ponderous tomes, occasional extracts both of figures and descriptive text were made, especially from the more rare and costly; but these, even when abridged, gave to the prodromus on which they were engrafted, the appearance rather of a manual than a prospectus.

Such were the chief steps which led to the compilation of this *vade mecum;* for, having thus far advanced, the author was persuaded to give it a more comprehensive character; and, to make it not so much a text book to the college lectures, as an introduction for general use, to those more elaborate standard works which constitute the body of the science. For most of these, even if consulted in public libraries, instead of being studied, as they should be, in the closet, are suited rather for the perusal of the veteran, than the novice; while others, which, when advanced, he cannot be without, seem to require some such initiation as this, to enable the pupil to consult them with advantage.

This primer may therefore be considered as a humble introduction to such standard works as those of Greville, Turpin, Vaucher, Dillwyn, Turner, Fries, and Fee, from which the materials of the Outlines of Algologia have been chiefly drawn, as well as to those others to which references will successively be made in the Outlines of Fungologia, Muscologia, Filicologia, and the subsequent departments of the science.

Elementary works are of necessity compilations in many parts. It is their lowly yet useful office to glean on every side, and aided by all their fellow labourers in the fields of science, who fling the liberal handfuls from every shock, to form a common sheaf for the sustenance of those who are as yet too young to work, or too weak in knowledge to gather for themselves.

Brett, in his principles of astronomy, has placed this matter in a very proper light. He says, "the advanced state of a science is but the accumulation of the discoveries and inventions of many. To refer each of these to its author is the business of the history of science, but does not belong to a work which professes merely to give an account of the science as it is; all that is generally acknowledged must pass current from author to author." This quotation* has been already made by one who is scarcely known to the writer except by name; still, one whom as labouring in the same field, though in a different part, he fain would call his colleague and his friend.

Much, therefore, that is absolutely new, should not be expected, nay, should scarcely be desired in such first steps to science; for established principles are to be inculcated, and truth is proverbially old fashioned. The author does not, however, mean to imply that modern discoveries have been neglected in the compilation of these outlines; he has already

* See the Preface to "Lindley's Introduction to Botany."

mentioned their magnitude and importance. As far as time and opportunity have permitted, he has sedulously consulted the works not only of past but also of present writers, and gladly acknowledges that he is indebted to both for very much of whatever may be found of worth in the following pages.

It is usual in semi-compilations like the present, to deprecate the charge of plagiarism by making the preface a confessional, in which catalogues are introduced of the works that have been chiefly followed. Were, however, such a list to be given here, it would be found of a most inconvenient length. For fully agreeing with Sir John Herschel that "Science is the knowledge of many, orderly and methodically digested and arranged, so as to become attainable by one," it is needless for the author to avow that he has read as many books as he could get, and has adopted and gathered freely from every side. Still that, as far as possible, honour might be given where honour is due, he has often, to his own inconvenience, quoted the original writer's words; and when other figures could more readily have been had, has thought it better to give the original illustrations. And now that the fruits of these researches are orderly and methodically digested and arranged, he trusts that the knowledge of many will be found to constitute a science easily attainable by one.

He does not, however, wish to shield himself from responsibility by deferring wholly to the authority of others; though names as great might in almost every case be given, as those already cited, as furnishing the chief materials of the outlines of algology. He feels himself as much responsible for that which he adopts as for that which is absolutely his own. Neither does he wish it to be supposed that there is nothing original in this work. He believes it will be found to possess, at least as much, if not more novelty, both in matter and method than is usual in such philosophical primers. Indeed, if there be any one feature about which he entertains more anxiety than another, it is the reception that will be given to those

changes which he has found it impossible to avoid making, in order to reduce materials collected from so many such different sources to an agreement in a common view. Whatever objections may be raised against it on this account, he is, however, fully prepared to meet; yet it would be wrong to volunteer a defence, and premature to anticipate objections; especially as at a future time this subject will become, in its regular course, the theme of consideration; and still more so, as he feels convinced that in reality the changes have been too few, and that they might have been introduced less sparingly, with manifest advantage.

King's College, London;
15*th March*, 1833.

PREFACE.

Natural history and natural philosophy are essentially sciences of observation. Facts are the only legitimate materials of such knowledge, the only bases upon which physical theories should stand. Analogy may be allowed to indicate, and speculation sometimes to suggest; but experience alone can be suffered to confirm those laws which induction may enact. When observations were few, the separate remembrance of the truths discovered was to most an easy task, and the unassisted powers of the human mind were sufficient to know all that then by man was known. But, as continued observations accumulated facts to an extent far beyond the compass of a finite comprehension, truths once known must have been neglected or forgotten, whilst others were learned, had not some schemes been devised for retaining possession of previous discoveries, and at the same time extending the bounds of human knowledge. Such schemes have been denominated *systems;* and scattered truths reduced to system constitute the rudiments of philosophy.

The distinction between a science and the things it treats of, though of primary importance, is too often overlooked; and the means mistaken for the end to be attained;—a fatal error, and one that leads to many misconceptions. For the latter are immutable, the former always changing; that is but the instrument of knowledge, these the matters to be known.

Physical truths are as much truths, though known for the first time, by man, to-day, as those which have been discovered a thousand years. Their antiquity is equal, though known but now; nor would it have been less had they by man been never learned. They were from the first discoverable, though not previously discovered; and if again forgotten, they would not cease to be.

If physical truths were only known in fragments, however great their accumulation, science could scarcely be said to exist; it is not until reduced to system that their indefinite acquirement can be profitably sought; for what addition to an unordered host of facts can be esteemed an advantageous increase? Still it is evident that system does not change the import of the truths that it collects, nor vary the nature of the facts that it arranges. System is but the discipline of science; as system, it adds nothing to, neither does it diminish aught, the store of facts it comprehends: how much soever systems vary, facts change not; these remain unaltered, however vaguely ordered, however effectively disposed. Bad systems may impede, and good ones may assist the progress of discovery, as they more or less commodiously distribute truths already known; still even the best are but the vehicles of learning, and not the knowledge they are destined to convey. Hence it is matter, not method, that deserves our chief consideration; for, as the subjects known increase, and the objects to be attained are varied, so systems must conform to the principles of the one, and be modified to suit the purposes of the other.

The revolutions of methods which mark epochs in philosophy should therefore merely be regarded as stages of maturation; and it should be remembered that such plans as may have been well fitted for a former state or condition of knowledge, may be utterly unsuited to the present: and again, that such as may be effective aids, for a certain purpose, may be wholly inefficient for another: truth is the subject, its discovery the object of philosophy; and truth is eternal. Hence the things to be known are always the same, how

much soever the successive discoveries of its several parts may modify man's still partial views of nature, and change the aspects of human knowledge.

A general view of facts discovered constitutes the theory of a science, as the application of such knowledge to specific purposes, if on principle, constitutes its practice. Hence, theories may be useful, even if distorted, as views may be of advantage, although they may be very partial; and perhaps imperfect theories and partial views are more fit for partial and imperfect knowledge than such as are ideally perfect and complete. Still the distinction between the facts known, and the theories by which they are connected into a system, should never be lost sight of: for knowledge, though little and partial, may be important; and, though incorrectly applied, may be in itself correct. Such errors are the inseparable consequences of partial and imperfect knowledge; its progressive increase has, however, a constant tendency progressively to demonstrate its true worth, and progressively to improve its applications.

Physical truths are not the less true because they are misunderstood by some or misapplied by others. Nature's materials may be perverted, and her working plans are often misconstrued; but this is our error, not her fault. Thus, we find that systems of science the most unnatural and vague, may be constructed of facts, the value of which may be indisputable and great; just as the materials that were wasted on a Babel would have built a pyramid; and as those same marbles which to the Turk are merely stones, were statues in the temples of the Greek.

These prefatory considerations, never wholly without their use, seem to be peculiarly required at the present time, when manner is often more prized than matter, and the things revealed less thought of than the mode of their revealment. When systems, useful in their age, are contemned chiefly because they are old, and those that are familiar slighted because they are common; and, moreover, when some plans, excellent for their appropriate uses, are perverted to purposes for which they are unfit, while those others they attempt to

supersede are injudiciously depreciated, merely because they are inapplicable to the performance of duties that are not only incompatible, but for which they never were designed. Still, though systems, or methods of study, should be regarded as subservient, not paramount considerations, the improvement of such schemes should be no less zealously pursued than the knowledge of the subjects which are by them to be studied, for both are intimately connected, and reciprocally influence each other.

With such persuasions, and on such principles, the present work has been composed; and differing as it does in its manner, though not essentially in its matter, from the ordinary schemes of introduction, it seemed to require thus far an apology and explanation.

The difference adverted to chiefly consists in giving the *subjective* precedence of the *objective* view; and, considering subjective botany in general to be distributable, like other branhces of natural history, into several subordinate sciences, each devoted to the especial study of one great natural group of plants; the structure, functions, and uses of which will collectively form a complete, though subordinate science, as well as, disjunctively, constitute the several parts of general vegetable physics, of systematic and economic botany.

Besides several minor collateral advantages, which, as they will become evident hereafter, need not be dwelt on now, there are two or three chief ones, the mention of which can scarcely be omitted, as they are more essentially characteristic of the scheme. The first of these springs immediately from the distribution, just referred to, of general botany into several subordinate sciences. For, by this means the organs belonging to the plants in every class are discussed in turn without being confounded with those that are peculiar to each or any of the others. The arithmetician will at once perceive how much mental fatigue will be thus avoided: for he well knows the number of parts continuing the same, how very much their permutations are lessened by forming them into groups, between which no interchange takes place; instead of suffering the whole series to be uselessly permuted.

As the first advantage admits an arithmetical illustration, perhaps a geometrical analogy may be allowed to indicate the bearings of the second. For, as the mathematician finds the benefit great of commencing with obvious and established truths, as thus, when they at length arrive, he can solve with ease problems the most recondite and abstruse; so likewise the botanist gains an equal advantage by following the ascending synthesis, which, in the same manner, proceeds from known propositions to those which are unknown. Such a demonstration begins with the simplest plants; with those which have the fewest and simplest parts; with vegetables consisting sometimes of only a single organ; and thence gradually proceeds to develope their combinations in the more complex structures, as each additional organ is added or evolved: until at length the most elaborate organisms, which, considered by themselves, would seem intricate and obscure, are rendered clear and intelligible, from many of their intimate component parts having been previously examined in detail, and in their distinct and independent states.

The third and last advantage, of which notice shall be taken now, is closely connected with, and may be regarded as in some measure the offspring of, the former two. It is the much more copious history which is necessarily introduced of all the classes, and especially of those which include the simpler plants, plants which in general are too cursorily passed over. Those persons who maintain, the plausible paradox, that already too much is attempted to be taught in elementary works, may not be inclined to regard this increase as an advantage. The author, however, holds a contrary opinion; he believes that, instead of too much being attempted, such works more frequently attempt to teach too little. The burden complained of as great and grievous, he believes to be made intolerable only from injudicious accumulation. If the whole armoury of science instead of being distributed for use throughout the ranks, be cast into a common heap, then its weight indeed may crush a stronger than Tarpeian frame. Still, such a fatal reward can be easily avoided, by letting the instruments and materials of each be kept separate and dis-

tinct from those of the other departments. And if principles, as soon as they are obtained, be applied to practice, not only does the burden never become oppressive, but, from the interest thus early given to the subject, much more can be easily and with pleasure borne.

Should, however, the above not be considered a sufficient or satisfactory defence of the occasional deviation from the current doctrines of the day, as well as the conjunction of many common names, with more scientific and imposing terms, let it in the first place be remembered that the philosophic nomenclatures and arrangements of the present time are so numerous and so various, that it is impossible to reconcile or follow all; and therefore, instead of strictly adhering to any one, it has been thought preferable to attempt to bring together the most valuable features of the whole. And, in the second place, it should not be forgotten that utility alone has been the ruling object of this guide; its highest aim, the humble hope of familiarizing science, and facilitating the acquisition of truths, the only legitimate materials of philosophy. Let these be, therefore, firmly held; and, when once surely made his own, the student may be as regardless as he pleases of the storehouse in which they have been found, and the machinery by which they have been purveyed.

Hence, in conclusion, the author would remind the reader that, the systematic cords by which facts are here, as it were, bound together into bundles, and the speculative vehicles in which they are conveyed to the student's mind, as materials to the workman's or the builder's hand, are never to be regarded as more than implements, often necessary, always convenient, for the advantageous application of the mental powers, and must not be mistaken for the work they are destined to perform: therefore, when the building is complete, the cords, the scaffolding, and the various tools, by which it has been raised, may, at the pleasure of its owner, be removed.

85, *Norton Street, Portland Place.*

SUBJECTIVE BOTANY,

INDICATED IN OUTLINE.

INTRODUCTION.

(1.) BOTANY, superseding the ancient *Herbcraft*, is the name now given to the science which relates to all those inferior ranks of the organic creation called PLANTS, or *vegetables*.

(2.) But what is a *plant?* What do we mean by this word *vegetable?* It is a term the most ignorant presume they understand, although the most learned are unable exactly to define; for a plant is, indeed, as Theophrastus long ago observed, "a various thing, of which it is difficult to give a definition."

(3.) Tell a clown it is difficult to distinguish an animal from a plant, he will smile incredulously, and perhaps will say, "Can I mistake *man-orchis* flowers for men?" but show him a

(*a*) Ophrys apifera, the Bee orchis. (*b*) Ditto, tuberous root. (*c*) Flower separate, to show the insect form.

(*d*) Ophrys muscifera, or Fly ophrys. (*e*) Tuberous root. (*f*) Flower separate.

(*g*) Aceras anthropophora, the green Man-orchis. (*h*) Root of the same. (*i*) (*i*) (*k*) Flowers separate, to exhibit their anthropomorphous appearance, as figured by Rudbeck.

conferva and a *polype*, a *lichen* and a *coralline*, a *flustra* and a

(*a*) Ceramium ciliatum, one of the confervæ. (1 *a*) A portion magnified. (2 *a*) A portion with fruit, still further magnified.

(*b*) Hydra fusca, one of the polypes, greatly magnified. (1 *b*) The same, in its contracted state.

(*a*, *b*) Agaricus campestris, common field mushroom.

(*c*, *d*) Medusa pulmo, a molluscous or acalephous animal.

flag, or even a *mushroom* and a *medusa*, and he will at once confess, at least by silence, if not by words, that he "kens not which they be."

(4) Such presuming self-confidence in what they know, is "the badge of ignorance and the curse of fools:" it is the humble privilege of the wise alone to doubt; and they who know the most are always the most sensible how little the most enlightened know.

(5) But this matter is apocryphal, not to the unlearned and the ignorant alone: physiologists the most astute have laboured, and do labour still, in vain, succinctly yet comprehensively to define a plant. The difficulty, however, lies not so much in the perception of the differences which undoubtedly do exist, as in reducing these perceptions to the progressive scale of a still very imperfect language. The dilemma somewhat resembles that in which an ancient philosopher is said to have been involved; who, when desired to state what motion is, after much consideration, rose from his seat, walked towards the inquirer, and replied "You see it; I can show it to you; but I cannot tell you what motion is." Thus also, to the opening question, a botanist might answer, "Here are plants; you see them; I can show them to you, even if I cannot precisely tell you what a vegetable is."

Aspidium Baromez.

This fern is commonly known as the Tartarian lamb. One of the best specimens the author has seen is in the possession of the Medico-Botanical Society of London, and of its general appearance the above figure gives a very good idea. It contrasts well with the following arboreous fern, the Cyathea glauca; showing, as they strongly do, the great variations in external form that prevail among plants which are naturally arranged in the same section, class, and order.—See also numerous other illustrations in the figures given in the subsequent pages.

Cyathea glauca, an arboreous fern.

(6.) Let not the bearing of this statement, however, by any one, be misunderstood! Remember, it is not science which *makes* the difficulty she here points out: she only shews what already is; just as a microscope does not *make* the hairs on a mite's back, but only brings them within our sphere of vision.

(7.) Examine for a moment some few specimens illustrative of the different departments of the vegetable world; such as mushrooms [vide § 57], flags [vide § 41, 47, 51], and mosses [vide § 59]; jointless and jointed ferns [vide § 64]; grasses [vide § 72], sedges, rushes, lilies [vide § 75]; palms [vide § 81], pines [vide § 85], cycases [vide § 85], and forest trees [vide § 97, 100], or other more showy herbs, and shrubs, and selworts [vide § 111]; of each of which extensive sections, examples, however copious, must of necessity be comparatively meagre, and yet which are scattered in such infinite profusion "o'er all the deep green earth," that their varied forms and beautiful appearances are familiar to the least observant. Let the inquirer examine these, and say whether they do not confirm the dogma of him of old, that a vegetable is a various, a very various thing, of which it is difficult to give a definition; and whether they do not equally proclaim that science does not make the difficulty she here points out; whether they do not declare that she only shows what already is, although it may have hitherto escaped our observation.

The perception of difficulties does not increase, neither does ignorance thereof lessen their extent. The unlearned do not know more truly because they are insensible of the imperfections of their knowledge, any more than a road becomes smooth to the purblind, merely because they do not see its roughness. What-

ever is, still is, whether men know it or know it not. Doubtless, from the beginning eight planets always were, although the ancients knew but seven; for Herschel's telescope did not create the Georgium Sidus, but only showed to man what mortal eyes had never seen before.

(8.) But the difficulty of diagnosis between animals and plants, and even between living and lifeless beings, so often and by so many dwelt on, is rather a speculative than a practical obscurity. Every one is sensible of differences existing between the numerous productions of nature; for, were not such differences obvious, the whole would be esteemed not various, but the same. All persons, then, distinguish the peculiarities that mark the successive grades of physical existence, though few are competent to state precisely in what that difference consists. The one is the unsought observation of the savage, the other the hard-earned achievement of the sage; the former a perception that no one can avoid, the latter a science in which, not seldom, the wisest are at fault.

(9.) Now this great and extraordinary variety, this almost infinite diversity, in the structure and functions, the characters and appearances, the properties and purposes of plants, which renders it so difficult to frame a concise definition, rigidly including the whole, and as strictly excluding all that WE *think* not plants, which circumstance so many have bewailed, and which some superficial philosophers have regarded as the reproach of botany, because it suits not their weak and artificial systems of arrangement, so far from being an "*opprobrium botanicum*," is, in truth, one of the chief advantages of which the science has to boast; so that, if we wished for a change at all, we should wish, although it is needless, that the variety were ten times greater.

(10.) Because, although the vegetable kingdom, by stretching to such wide extremes, may render the absolute definition of a plant somewhat abstruse and difficult; and although in some cases, at the confines of the animal and vegetable reigns, doubts may arise as to whether certain microscopic beings are animals or plants; belong to this kingdom or to that, or, in fact, to either, still their ambiguity, which has been lamented as an extreme disadvantage, when rightly viewed, becomes a guide, as it at once affords an index to elucidate the things themselves; for their very obscurity indicates their station, by referring them to the debateable land of natural existence. And, furthermore, it of course will follow that

the greater the differences existing among decided plants, the stronger will the contrasts be, and, of course, the more readily will they be distinguished from each other: a secondary advantage, which, in practice, far outweighs any slight inconvenience attending the diffuseness of the primary definition.

(11.) Still when, as botanists, we presume to talk of plants, it may fairly be required that we should attempt to solve the question that so continually recurs: viz. what is a vegetable? For plants are the principles upon which all botanic lore depends; they are the very subject matter upon which we must discourse: and as, although we cannot absolutely, we can relatively define them, this relative definition should be given; and the more so as it will, in truth, be found to be all that can legitimately be sought, in any department of natural philosophy.

(12.) With this relative definition we shall therefore rest content; for the search after the abstract and the absolute too often becomes, as Butler well observed, on a somewhat similar occasion,

"An ignis fatuus that bewitches,
And leads men into pools and ditches."

(13.) To show what constitutes this various thing we call a vegetable; i. e. to indicate the various phenomena exhibited by certain physical existences, to note what characters distinguish the organic from the inorganic world, and amongst organic beings the vegetable, or merely vital, from the animal or sensual creation; in a word, which constitute the several grades of men, of brutes, and of plants, is doubtless a worthy task; and, as the pursuit involves much useful and important knowledge, it must form a part of every enlightened botanist's researches. It is the time, and mode of investigation, that admit dispute; not the necessity of the research itself.

(14.) Plants are very numerous, and often very various; but the relative similitudes and comparative differences by which they are associated and distributed into more or less comprehensive groups, and allied to or distinguished from each other, as well as to and from the contingent animal and mineral kingdoms, even when great, can be duly appreciated, and when slight, can often be perceived, only by those who are conversant with their positive characteristics; i. e. are practically familiar with the subjects to be distinguished and defined. Hence, as plants are the subjects

of inquiry, a practical demonstration of their positive individual characters would seem rightly to precede a collective theoretical definition of the vegetable reign, and its comparative demarcation and extent; and such is the plan we here design, in the first place, to follow.

(15.) For the present, therefore, we shall let the more speculative problem pass; to it, however, we shall return hereafter: and its consideration is only now delayed, that a previous practical demonstration of plants, as they are found in nature, may the better enable us to venture on its solution. Hence, to a not distant future we postpone the definition of a plant, and now propose, as a more useful preliminary step, to practically show what a varied thing a vegetable is.

(16.) Plants are the subjects of botany; their attributes the objects of the science: hence, two schemes of study, the subjective and the objective, lie before us; each of which may be pursued in opposite courses; i. e. either by analysis or synthesis, whence the anterior and posterior arguments result; between these the selection must be made. The former descends from generals to particulars, the latter ascends from effects to causes; that being essentially more abstract, this more practical, in its course. Each has advantages peculiarly its own; hence, both should in turn be studied, and neither exclusively neglected or pursued. But, as the anterior argument requires much antecedent knowledge, while the posterior can trace back from none, that being the fruits of learning, while this is the means to learn; although the first is the most comprehensive, the last is the most familiar, and hence it is that with which we shall commence our labours.

(17.) Although differing essentially from the usual schemes of investigation, synthesis shall here precede analysis, and the subjective now be made the forerunner of the objective view; for it seems advisable, at least occasionally, to commence with a practical demonstration of plants as they are found to exist in nature; and to show their positive characters before comparisons are instituted between them and the other kingdoms of the organic and inorganic worlds: in fact, first to have materials to compare before comparative views are taken. Hence, after giving a general conspective glance at the whole, it is proposed to demonstrate the

special structures, functions, properties, and uses of each succeeding group of plants, from the lowest to the highest grades; and this before any general views or comparisons are instituted, even between the varied developments of equivalent organs, as pervading the whole vegetable kingdom, and much before any are made between the different, and often essentially diverse, constitutions of the adjacent animal and inorganic reigns.

(18.) It is evident that the subjective synthesis will demand much less previous knowledge, and require much less to be assumed, than any other mode of investigation. Still, even here, something must be accorded: we must grant what, however, few would venture to deny, for it is a postulate without which no step can be advanced; viz. that the examples adduced, and to which reference has been made, as the flags, funguses, and mosses, ferns, grasses, and so forth, are truly vegetables. These groups have been selected merely to illustrate the varied characters of plants: that they are really such, must be *proved* hereafter; that they are what they are described, must be *granted* now.

(19.) Something must be assumed in every science; and, to profit by the experience, the pupil must be content to take something at first on the authority of the teacher; seldom, however, more than admits of no dispute. For, although it is convenient, in order that every point, even the simplest, may receive its due share of consideration, to assume, and, as far as possible, to act on the assumption, that all students are totally ignorant of the subjects to be discussed, yet it is notorious that such *tabulæ rasæ* are never met with: many things are unavoidably known to almost all; our very existence convinces us of many: such, therefore, as such alone should be, are the postulates assumed; and, from the certainty of things already known, we either proceed to inform ourselves respecting those which are as yet unknown; or not only this, but, from knowledge thus acquired, we are enabled to correct those errors by which, either from ignorance or prejudice, we had been previously enthralled.

(20.) The following simple enunciation of some of the chief results of the analytic scheme, viz. the segregation of acknowledged plants to constitute the vegetable kingdom, and the subordinate distribution of this kingdom into secondary and tertiary groups, or classes, if used, as here proposed, merely as a guide,

may also with advantage precede the development of the synthetic associations, although the detail of the analysis be deferred, and the results, as it were, almost empirically assumed.

(21.) In the following practical solution of the problem, "what is a vegetable?" examples will, therefore, at once be drawn from each of the most commonly acknowledged and the most strongly marked regions and classes, and from several of the subordinate departments of the vegetable reign. Most of these groups have been long established and generally received; and, although their names may at first have been waywardly imposed, custom has now rendered them more or less current terms; and science, if she has scrupled to adopt the popular language, has not scrupled to avail herself of popular observations, and has frequently followed and confirmed the popular distribution—as a reference to these and future tables and diagrams will show: and as, with very slight modifications, many of our common and familiar words may be rendered synonymes of less familiar technicalities, they will now be used in preference; not, however, as superseding the terms of science, but as paving the way for their introduction.

Plants or Vegetables.	Musts or Worts	Flags or	Algæ	ACOTYLEDONES	Plantæ vel Vegetabilia.
		Mushrooms or	Fungi	Mycaffines	
		Mosses or	Musci	CELLULOSÆ	
	Leas or Herbs	Ferns or	Filices	MONOCOTYLEDONES	
		Grasses and Sedges, or	Gramina	Termaffines	
		Palms, Lilies, &c. or	Palmares[a]	ENDOGENÆ	
	Creses or Plants	Pines and Zamias, or	Zapini[b]	DICOTYLEDONES	
		C essels, Fruges, vel	Eucarpæ[c]	Crescaffines	
		Selworts or	Selanthi[d]	EXOGENÆ	

(22.) It is curious to observe, notwithstanding their characteristic peculiarities, the general coincidence that subsists between the popular and scientific distribution and nomenclature; for the Algæ, Fungi, Musci, Filices, Gramina vel Segetes, &c., are but technical synonymes for nearly equivalent classes of plants, known to all as Flags, Mushrooms, Mosses, Ferns, Grasses, Sedges, and so forth: and this is still further remarkably the case in the

[a] Including the Petaloid Endorhizæ of Richard, or Monocotyledons of Jussieu.
[b] Including the Synorhizæ of Richard.
[c] Including the Exorhizæ of Richard.
[d] Including the Cytineæ and Rhizantheæ of authors.

Primary Groups admitted by Linnæus.

Vegetabilia	Monocotyledones vel Fruges	Palmæ or	Palms	(Principes)
		Gramina or	Grasses	(Plebeii)
		Lilia or	Lilies	(Patritii)
	Dicotyledones vel Plantæ	Herbæ or	Herbs	(Nobiles)
		Arbores or	Trees	(Proceres)
	Acotyledones vel Cryptogama	Filices or	Ferns	(Novaccolæ)
		Musci or	Mosses	(Servi)
		Algæ or	Flags	(Vernaculi)
		Fungi or	Mushrooms	(Nomades)

(23.) We attempt not here to justify the classes and the regions into which the vegetable reign, or kingdom, has been almost universally distributed: this will engage our subsequent attention. Neither are we called on to defend the names which custom has in general too loosely applied thereto, and which science very often too fastidiously condemns. Much of the arrangement seems very natural, and most of the terms, if used with somewhat more precision, highly expressive: and why should not English names be as carefully defined as Greek and Latin words? for, although not all so classically elegant as some of our botanical nomenclature is, they are equally intelligible, and far more euphonious, than many semi-barbarous technicalities; but of this, more hereafter: neither their correctness nor their elegance concern us now; sufficient is it for the present purpose that they are generally known, as we merely propose to use the vulgar terms, because, although many persons are well versed in botanical language, to some it may not be familiar. That our veterans will be pleased to excuse this innovation, there is no doubt; for they are ever the last to condemn the adoption of any method which may tend to familiarize science, and facilitate the progress of the student. Who is there that has not at some time felt the galling yoke of technicalities? Who is there that has not found that, to learn a science, and at the same time to be obliged to learn a language, is indeed to have the tale of bricks demanded, while the straw to make them is denied. We shall, therefore, in order to lessen or avoid this evil, in conjunction with the scientific names, employ the common English synonymes, whenever such exist; and, when there are not any known, translate the stranger epithets into our mother tongue.

(24.) To this scheme no valid objection can be made; for, if of temporary service only, and at once discarded when its first ob-

jects have been attained, it must still, by lessening the difficulty of acquiring a sometimes abstruse terminology, eminently subserve the purposes of the general conspectus, of those several most important and commonly accepted regions of the vegetable world, which is to precede the subjective outline of each included section.

GENERAL OUTLINE.

(25.) In the ocean, in rivers, and especially in stagnant water, as well as in many damp situations on shore, myriads of minute animals and plants exist, which for ages were utterly unknown; or, if noticed, were mistaken for the foam of the waves, or the exuviæ of the bodies amongst which they abound.

(26.) So minute are some of these infinitesimals of vitality, that, in a drop of water, it is said there might be suspended five millions; and eight hundred millions, that is, almost as many as the entire human population of this globe, might, if collected, be contained in the space of one cubic inch.

(27.) Yet, small as are these *monads*, their structure is by no means so simple as is their bulk reduced; for Ehrenberg describes those species which, from their ultimate atomic minuteness, and resemblance to fine dust, have been called *termo*, *atomus*, and *pulvisculus*, to possess each from four to six, and in the atom many stomachs; and, furthermore, in the allied genera,* he has counted no fewer than from one to two hundred stomachs: i. e. from one to two hundred internal sacs, or digesting pouches, into which coloured fluids have been seen to pass; and in many others, these organs are equally elaborate, and the collateral structures curious in the extreme.

* *Cyclocœla*, *Orthocœla*, *Campylocœla*, and *Paramœcium*. From Ehrenberg's monograph on Infusorial animalculæ.

(28.) The most minute vegetables, however, which have been as yet discovered, are much less complex in their structure than animalculæ are found by zoologists to be; for these, in the lowest grades that have been a urately examined, appear to consist of simple cells, or threads, [vid. § 41, 47, 121, &c.] either free or springing from a slimy film, and which, although frequently associated, and often in contiguity, appear, in many cases, to have no necessary connexion with each other.

(*a*) Masses of Globulina botryoides, (Turpin.)
(*b*) Groups of plants removed and magnified: globules, some free and some uniting.
(*c*) A single parent cell, in which many smaller cellules are contained, and from which some have escaped. Also a young cell, in which they are just beginning to appear.
(*d*) Section of such a cell, to show the parental attachment of the young.
(*e*, *f*) Groups of cells and cellules, more or less connected or distinct: the younger opaque, and becoming transparent by extension.
(*g*, *h*, *i*) Cells united, and the form more or less changed by their union and compression.
(*j*) A distorted cell, probably formed of several united, their intervening coats becoming obliterated.

(29.) Allied to these simplest plants and animalculæ are certain ambiguous beings, which, on the verge of both kingdoms, seem to belong indisputably to neither: for in them some of the most distinctive characteristic signs of animals and vegetables are so conjoined, that at times they would appear to be both, and again indifferently either. Thus, their germs take root and grow like ordinary plants, while the fruit they bear seems to be possessed of voluntary motion, and to pass, in its development, through a stage of animal existence, before it, in its turn, takes root, and bears another generation. *Zoocarpes*, or *fruit animalculæ*, are the names which, not improperly, have been given to these connecting links of the animal and vegetable reigns.

(30.) Through these neutral tracts, which, while they bound, connect both kingdoms, the oft-disputed line of demarcation runs. From such obscure and debateable beginnings, plants and animals, as the dominion of each is on either side confirmed, gradually become less questionable in their forms, and assume their more essentially diverse structures. At this utmost verge of the vegetable domain, the present demonstration shall commence.

FLAGS, OR ALGÆ.

(31.) Several large and very curious groups of plants, which are allied to the Zoocarpes, but distinctly vegetables, have been collectively denominated Flags, or Algæ. Their English name has reference to the flagging habits of a large proportion; as, for example, the sea-weeds, which are usually fixed to rocks or stones, and flag, i. e. droop or float, according as the water quits them or bears them up. *Alga*, the technical synonyme, is said to be derived *ab algore*, coldness; as if the nominator had supposed that some of these productions, which are chiefly aquatic, were formed by the congelation of films or drops of water; to which, indeed, many bear no slight resemblance. To this ancient hypothesis there seems to be allusion in the names of several: e. g. *Ulva* (ab uligine,) signifies ooziness or moisture, as our English word *Laver*, from *laver* (à lavo), to wash, literally means *froth, scum*, or *lather*; whence, perhaps, lāver or lăver. Again, *Halymenia*, if literally translated, gives a pellicle of sea-water or sea-

membrane. Thus, also, *Achnanthes* is sea-froth; *Anthachne*, froth-flower; and *Alcyonidium*, the foam of the sea.

(32.) Many other similar examples might be given, for they continually occur, and in every language; although, when veiled in foreign tongues, or even when custom has given them an adventitious meaning, their original significations are not attended to. Thus, our own *mildew* is but a contraction of *soft* or *mild dew*, referring to the delicate texture of the minute plants of which mildew consists, and of which each spot is as it were a forest.

(33.) In the infancy of philosophy, such fanciful speculations and ideas, which we now think absurd, were common to all branches of science, and to other departments of natural history, as well as to the study of plants. Indeed, it is comparatively not long since an elaborate and learned disquisition was written, in order seriously to prove that the "flowing gossamer," the aerial spider's web, so common in autumnal mornings, is *not* scorched or frozen dew. The names alone are now happily all that remain to us of many of these crude doctrines, which we are too apt to denominate absurdities; not remembering that many of our received hypotheses, it is more than probable, are equally destitute of truth. They are but the clouds which attend the morning twilight of philosophy, and, as the sun of science rises, like the early dew, they pass away.

(34.) This class includes, in its several orders, sections, types, and genera, some of the most curious living structures which as yet are known. Protophytes, just emerging from lifelessness to life, and beings which, almost animals, still linger on the confines of the vegetable world.

(35.) Many of these microscopic creatures are so simple in their nature that their very simplicity renders them a doubt. Here, indeed, is the problem of which mention has been already made; for, so similar are many of the tribes of *algæ* and of *fungi*, that it is not only sometimes indeterminable to which of these two great classes certain individuals should be referred, but whether, in truth, they are plants at all; for, strange as the statement does appear, many of them may be parts of other organic beings; and to some there has been attributed an half-animal existence.

(36.) Upon this point, however, modern research has thrown very considerable and very important light; and several of those ambiguous things called infusorial animalculæ, and named and

arranged as such in their systems by zoologists, and to which, by some, an equivocal or fortuitous generation had been most gratuitously attributed, it is more than probable are not of an animal but of a vegetable nature: and, besides this, very many of the moving corpuscules, which have often been mistaken for monads, and which hence were once most unphilosophically supposed to have sprung into existence without parental aid, are proved to be merely portions of dissolved or dissolving organic matter, loosened in its structure, and put into motion by physical powers, which had previously escaped detection by the observant eye of man. Allusion here, of course, is made to the curious phenomena described by Porrett under the name of *Electrofiltration*, and which Dutrochet has termed *Endosmose* and *Exosmose*, i.e. a *flux-inwards* and a *flux-outwards*, from the circumstance of two currents of different strengths being noticed to pass through organic membranes, when the fluids on either side are of different densities or in different electro-chemical states; and which will either fill or empty a fixed saccule, or put a moveable one in motion. This fact was first observed, by Dutrochet, to take place in the cellules of a small conferva, or moss-like production, which he detached from a fish's tail; and hence it comes properly to be considered here. Each portion of this moss (?) consisted of a filament and saccule, from which globules were expelled, and into and out of which the currents of fluids passed. He produced other similar globules, by putting pieces of flesh into the water, so that their formation was not connected with the living state of the fish. He saw these globules spread throughout the fluid, agitate themselves in divers directions for an instant, and then precipitate themselves to the bottom of the vessel.

(37.) But methinks I see some ultra-utilitarian smiling at the thought of a grave philosopher being thus engaged, for hours, in watching the motions of a corpuscule so minute as to be scarcely visible to the naked eye; and methinks I hear him ask "cui bono?" a question which any child may ask, but one that the wisest philosophers must often find it difficult to answer, although they may be far from admitting the pertinency of the interrogation. When such queries are proposed, as they often are, I love to meet them with Franklin's counter-question, "What's the use of a baby?" for no one will venture to inquire what is the use of a man.

The experiments which have led to this digression as yet are in

their infancy; but, even imperfect and crude as they confessedly at present are, they have already thrown much light on some very obscure parts of animal and vegetable physiology, and they promise to afford much more: they certainly disclose one of the most curious physical forces which have been discovered in modern times, and the just value of which we have not at present the means of estimating.

(38.) The same observations apply, and perhaps with still more truth, to that most curious discovery lately made by the celebrated Dr. Robert Brown, who has shown, by a most unexceptionable series of experiments, that locomotion, even when apparently independent of external forces, may and does exist among particles that are absolutely lifeless; nay, which have never been alive: so that, should not this phenomenon admit some more probable solution, it would seem that the long-established definition, which declares matter to be inert, may perhaps require a serious modification.

This apparently independent motion of the molecules of matter may appear to some to be a close approximation to the vital motions of plants, or the spontaneous movements of animals; and, indeed, the idea would seem more feasible than the belief of some German philosophers, that crystallization is an effect of vitality. The facts are simply these: that grains of pollen, particles of dead plants, some of which have been in herbaria for upwards of a century, nay, even fragments of powdered glass and stone; when diffused through water, and viewed with a good microscope, are seen to be in a constant state of motion; and this independent of any evaporation of, or currents in, the fluid; nay, still to maintain their restless activity when hermetically sealed between two plates of glass, so as to exclude, as far as possible, all external agitation, and are found, even under such circumstances, to continue their motions unremittingly during an indefinite period; nay, even after the lapse of months, (I believe we may now say years,) to be as full of motion as when first observed.

(39.) This discovery, as just now hinted, has been thought by some to militate against the ancient dogma, which enunciates the inertia of matter. It would ill become me to advance any speculations other than as mere hypotheses; and this the more especially as the discoverer himself, with that modesty which always attends true genius, does not even venture a speculation. I, therefore,

scarcely dare to suggest that it would be desirable to ascertain whether these movements may not be indicators of external motions, so slight as to be imperceptible to other means, rather than as inherent in the particles themselves. Just as many atmospheric changes are notorious with the water, that are utterly inappreciable with the mercurial barometer: and as the expansions of bodies by heat, and the vibrations of sound, are measurable by some instruments, which are imperceptible by others; so it would be desirable to ascertain whether the motions of these molecules do or do not depend upon vibrations, otherwise imperceptible, communicated by distant moving bodies to the surface of the earth, or to the matters on which they stand; or whether it is possible, as some of the movements seem very constant and similar, that they can evidence the motion of the earth itself, and thus afford the means of constructing a delicate *kineometer*.

(40.) But although many pseudo-*animalculæ* and (if we may be allowed the parallel word) *vegetalculæ* (?) are thus shewn not to be *those* wonders they were once supposed to be, and although locomotion is thus proved not to be absolutely diagnostic of life, still they are not the less wonderful now that they are regarded as what they truly are, lifeless corpuscules, put in motion by newly discovered and extraordinary laws, which their observation has been the first to reveal, than when they were considered paradoxes, and almost a reproach to natural science. And besides, even after their exclusion from the organic realm, there still remain many living beings, as simple in their structure and as curious in their functions as imagination can well conceive a vital organization to be, or ever to have been.

(41.) For example, the slimy matter often seen on rocks and stones, on hard gravel walks, and on damp walls and cellars, or on the glass of windows, garden pots, and so forth, and which is often so minute as to be lost to ordinary vision, consists of curious and most admirable vegetable structures. All the green pulverulent coating seen on old trees and palings is also found, by microscopic observations, to be composed of an infinite number of small plants, of an exceedingly primitive formation.

[Vide "Outlines of Algologia," sections *Nostochinæ*, *Fragillinæ*, *Byssinæ*, &c.]

Chlorococcum murorum.

a, natural size,

b, granules magnified.

This is the Protococcus viridis of Agardh. It was first discovered in this country by my friend the Rev. J. M. Berkley, on the walls of Christ's College, Cambridge, and figured by Dr. Greville, who has shewn it not to be a protococcus, but a chlorococcum.

(42.) The slimy masses known as Will o' the wisps, or Nostocs, are instances of other allied species, some of which are called by the common people "flowers of heaven;" a name which they deserve more than many that are often given to plants, if it be true, as the old herbalists declare, that, "infused in brandy, they cause a disgust to that liquor in those who drink of it;" for, as Johnston adds, they would then become "an excellent remedy for the '*potatores summi.*'"

(43.) Not one of the least curious of the lowly flags is the "red snow," which excited so much attention on Captain Ross's return from the North Pole in 1819. This phenomenon seems in some cases to depend upon the sudden appearance of a very minute plant, which the microscope declares to consist of small cells filled with a red fluid, and which is referred to a genus named, from its very simple structure, "*Proto-coccus.*" This plant, as well as the Palmella cruenta, or gory dew, Lepraria kermesina, or bloody rain, with many others called reeks or earth-sweats, as well as certain minute animalculæ, will sometimes suddenly appear in such great abundance as even to tinge pools of water with the hue of blood, to make red stains on the sea shore, and to discolour considerable tracts of ground, so as to simulate red snow, or dew or rain; and such in fact the appearance is vulgarly supposed to be. These occurrences are often regarded by the ignorant as of sinister omen; indeed, whole towns have been occasionally alarmed with the report, that, in the course of a single night, the water of their pools had become changed to

blood; and the dismay was not relieved until a philosopher exhibited to the eyes of many the minute corpuscules which had wrought the change of hue, and which were easily separable by filtering the fluid.

(44.) Palmella cruenta, or gory dew, is common in many places: I found it abundantly, during 1831 and 1832, at Oxford; and it is frequently observed in damp situations, forming "broad indeterminate patches of a deep rich purple, with a shining surface, as if blood or red wine had been poured over the stone or ground." "During dry weather it contracts, grows dull, and disappears; but after rain spreads anew, resumes its sanguine colour, and becomes conspicuous even to vulgar gaze. Its history affords (says Johnson, in his Berwick Flora,) an easy explanation of a phenomenon considered supernatural by monkish chroniclers, and to which Drayton, in his notes to Polybion, refers. "In the plain near Hastings, where the Norman William, after his victory, found King Harold slain, he built Battle Abbey, which at last (as divers other monasteries) grew to a town enough populous. Thereabout is a place which, after rain, always looks red, which some have attributed to a very bloody sweat of the earth, as crying to heaven for revenge of so great a slaughter."

(45.) But not only have we at times showers of the so-called red or bloody snow, rain, &c., and gory dew, ice, and so forth, produced as above explained, but occasionally these storms and dews are found of different colours, as green, blue, and yellow. These analogous phenomena are owing to plants not very different in their nature: the blue to *Byssus cobaltiginea*, the green to *Palmella botryoides*, the yellow to *Lepra candelaris* or *chlorina*, and other tints to other plants. "Both snow and ice were seen stained with red, green, and blue, by the late expedition, under Baron Wrangel, to the Frozen Ocean," (N. L. S.;) and Humboldt says, that red hail has been seen to fall at Paramo de Guanacos, on the road from Bogota to Popayan. Agardh, in an interesting memoir, mentions several of these supposed preternatural occurrences, that in different ages have been recorded; some of which have been looked upon as direct signs of the anger of the Deity. The learned professor observes, that red snow is very common in all the alpine districts of Europe; where it is, most probably, of the same nature as that brought from the north pole by Captain Ross. Saussure saw it in

abundance on Mount Brevern, in Switzerland, frequently among the Alps, and elsewhere; Ramond found it on the Pyrenees, and Sommerfeldt in Norway. In March 1808, the whole country about Cadore, Belluno, and Feltri, was in a single night covered to the depth of twenty centimetres, with a rose-coloured snow; at the same time, a similar shower was witnessed on the mountains of Veltelin, Brescia, Krain, and the Tyrol. A similar one occurred at Tolmezzo, in the Friaul, between the 5th and 6th of March, 1803; and, on the 15th of April, red snow fell on the mountains of Toual, in Italy. But the most remarkable red-snow shower on record was that which fell on the night between the 14th and 15th of March, 1823, in Calabria Abruzzo, in Tuscany, and at Bologna; consequently, along the whole chain of the Apennines.

Agardh considers this remarkable substance to be referable to the lowest order of the Algæ, and to stand as a distinct genus, which he calls *Protococcus*, upon the very limits of the animal and vegetable kingdoms. Saussure, indeed, by finding that the red snow of the Alps gave out, when burnt, a smell like that of plants, concluded that it was of vegetable origin; but he supposed it to consist of the farina of some plant; although he could neither account for its having ascended to such elevated regions, nor mention a plant whose farina is of that colour.

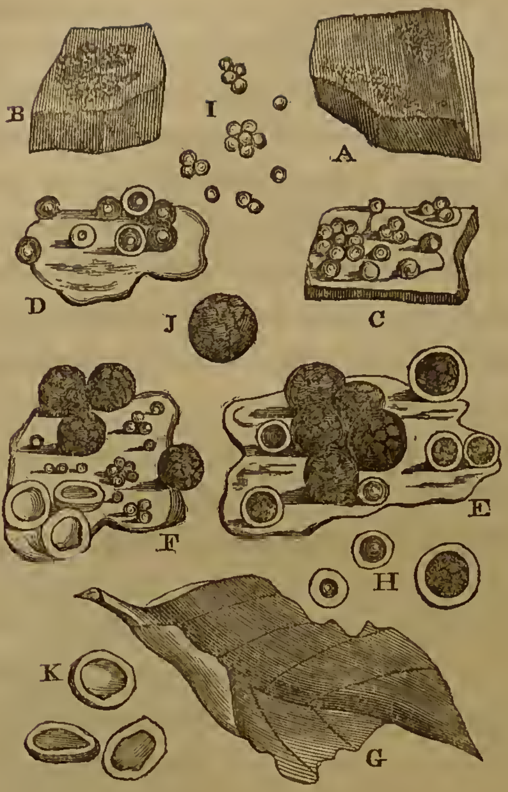
"Besides the (gory dew) *Palmella cruenta*, which is similar in its structure to the red snow plant, other low vegetable productions have been noticed by different authors as possessing a similar colour: such are the *Lepraria kermesina*, which, by the way, is considered only a particular state of the red snow plant itself, and the *Byssus cobaltiginea*. These are always found in situations in which they are exposed to the intense action of light, such as vast plains of snow, or masses of glittering limestone; whence it is inferred, that the colour of the red snow is attributable to the action of light, modified, in some mysterious manner, by the nature of the body on which it strikes: in confirmation of which hypothesis, it is remarked that, when Lepraria kermesina is found under the stems of trees, stones, or in the crevices of rocks, where light can scarcely gain admittance, its colour gradually passes from red to green.

"The chief difficulty in the way of this explanation of its nature, is in the statements of so many observers, that the red snow falls from the air. Professor Agardh, however, attempts to parry this by

shrewdly remarking, that, as all the persons who mention its fall agree that *it fell in the night*, such a statement is as much as to say that *no one saw it fall*. He is of opinion, that the Protococcus, or red snow, is called into existence by the vivifying power of the sun's light, after its warmth has caused the snow to dissolve, and accompanied with that incomprehensible power in white snow of producing a colour; and, moreover, that it first attracts the eye when there is a considerable quantity, in the same way that we do not see the colour of the drops of water till they have accumulated in the ocean." (*News of Literature and Science.*)

(46.) Notwithstanding the ingenuity of Agardh's reasoning, it appears to me much more probable that the red snow does really sometimes fall, and that the small plants of which it consists are at at least occasionally of atmospheric growth: for, allowing the Professor's argument its full strength, and allowing that the showers have been chiefly nocturnal, and that they have first been observed early in the morning; and disregarding the evidence of those who state that they have been *seen* to fall, the sudden appearance of the plants over such immense tracts of country as "along the whole range of the Apennines" can scarcely be accounted for by progressive propagation, however rapid, or by any other means than their aerial transportation. That such migration is probable, will be admitted by all who know that the propagating organs of these plants are of extreme minuteness, that they evaporate like steam, and rise like smoke and dust into the air; in the different strata of which they may float, and be borne about by winds, until the cellules have absorbed so much atmospheric moisture as to be of a greater specific gravity than the medium which has hitherto borne them up. This view will likewise account for their inclusion in the red hail, the appearance of which is otherwise unexplained; for that *it* falls is without question: and that there are situations which will afford abundant migratory supplies, is evident from Captain Ross's statement, that the mountains he found covered with red snow are about eight English miles in length, and six hundred feet in height. The red snow he also observed to penetrate, in some places, to a depth of ten or twelve feet; and he says, it seemed to have existed long in the same state.

(47.) There are excellent figures of the red-snow plant, both in Brande's "Journal of Science" and Greville's "Cryptogamic Flora:" the latter, however, being the most satisfactory in its details, has been the authority to which we have deferred.



A, B. Proto-coccus nivalis, or red snow, on blue and pale limestone, from the island of Lismore.

G. Ditto, on a leaf, from the same place, both natural size.

C. A group of globules.

D. Globules, with their subjacent gelatine, or *thallus* removed from the stone.

E. Mature globules, mixed with younger ones.

F. Mature globules, some entire, some burst, and the escaped granules lying on the slimy thallus.

H. Young globules, of different ages.

I. Granules more or less magnified.

J. Full-sized globule.

K. Globules after the granules have been discharged.—Grev. C. F. 251.

(48.) These simple plants, some of which constitute the so-called red snow, and hail, and rain, and dew, and others, which consist of one or several cellules, distinct or coadunate, give way to more advanced and regular structures in the *Confervinæ*, or *Boneworts;* and these, again, to the higher grades immediately contingent, known familiarly as sea-weeds, lavers, or kelp-ware.

(49.) The Sea-weeds, or Fucales, are followed by the land-flags, *Lichens* or *Lichenales*, which latter have been called *Algæ aëriæ*, to distinguish them from their aquatic allies; and, as they affect a very different station, they exhibit, as they leave the water, several important modifications of structure, to fit them for the peculiar functions they are destined to perform.

(50.) The *sea-weeds*, or *wrack-worts*, (Fucales, Phycæ, or Thalassiophyta,) including the Lavers (Ulvinæ,) and the Kelp-ware (Fucinæ), are generally water plants, scarcely ever growing in situations that are not frequently submerged. The *lichens*, on the contrary, are as universally aërial plants, affecting often peculiarly arid sites; fixing their shield-like bases on bare and barren rocks, or dead but not rapidly decaying timber; and, when growing upon living trees, not deriving nourishment therefrom. Hence being what are physiologically termed Epiphytes, to contradistinguish them from the true parasites, such as fungi, which not only

grow upon, but draw their nourishment from, the other vegetables to which they are attached.

The marine Algæ were formerly, for the most part, included in the single genus Fucus, as the land-flags were in the single genus Lichen, but the groups of species are in both as generically distinct as in any equivalent orders of terrestrial plants; and hence they are now considered and named as such. The aquatic flora, so long neglected,—that, what was formerly considered knowledge can be regarded as little more than a veil for ignorance,—has, by modern research, been already made a very important and interesting branch of study; and it promises to become much more so, as they well know who ever have explored the vegetation of the sea, and all will soon confess, who shall, like us,

> "Still tread, from rock to rock, in pleasing trance,
> And note the novel forms that deck the sides
> Or float upon the surface; too fair
> Either to be divided from the place
> On which they grow, or to be left alone,
> To perish in their beauty."

(51.) The history of the Fuci, as yielding iodine and kelp, two such valuable articles in medicine and commerce, affords an instructive lesson to those persons who hastily and presumptuously condemn all things as useless, the use of which they know not: for

Fucus vesiculosus, or Bladder-wrack.

(*a*) Upper part of the frond, with several terminal concepticles.
(*b*) Section of a conceptacle.
(*c*) A globular mass of spores and filaments removed from the conceptacle
(*d*) The filaments and spores still further magnified.
(*e*) Filaments that issue from the pores of the frond.

that very weed confers great benefits on man, who for ages stigmatized it as the synonyme of things most vile and worthless, useless and dispised. "Alga *inutilis*," exclaims an ancient poet; "*Vilior alga est*," in a tone of contumely, he adds; "*Refunditur alga*," repeats another bard; the sea itself spurns forth the worthless flag: that flag, the gathering of which for years enriched both peer and peasant on our northern coasts; the very flag that now affords the iodine which really does relieve that evil which the *manus regalis*, the boasted royal touch (if it ever benefited the superstitious) so long has failed to cure.

(53.) The LICHENS are plants familiarly known even to the least observant, as giving much of the venerable air of antiquity to aged trees, by covering their broken limbs, and reconciling the beholder to the deformity of decay. They likewise impart that subdued appearance and softness in colour and in outline which renders ancient buildings, by their calm grandeur, peculiarly impressive: hence, in our language, often so admirably expressive, they have been called "*time-stains;*" a name which may vie in force and elegance with any that in any other tongue they have hitherto obtained, and which, though long all but obsolete, may well demand its restoration to general favor.

The lichens afford several valuable dyes, a few drugs, and occasionally some food to man, though much more to certain beasts: for example, the *Cenomyce rangiferina*, or rein-deer moss, is the chief support of the Lapland herds. But the immediate uses made of these plants by us are insignificant, indeed, when compared with the functions they perform in the general economy of nature: here their utility is vast, and their value may almost be stated to be in an inverse ratio to their size.

(54.) Linnæus called the Algæ, *Vernaculi*, or bond slaves, regarding them as being fettered to the rocks on which they grow. The title is particularly appropriate, and especially when applied to the lichens, which are, as it were, chained to the soil they labour to improve for the benefit of others, though from it they derive no nourishment themselves.

The first conquests of life over death, the first inroads of fertility on barrenness, are made by the smaller lichens, which, as Humboldt has well observed, labour to decompose the scorified matter of volcanoes and the smooth and naked surfaces of sea-deserted rocks, and thus to "extend the dominion of vitality." These little plants

will often obtain a footing where nothing else could be attached. So small are many, that they are invisible to the naked eye, and the decay of these, when they have flourished and passed through their transient epochs of existence, is destined to form the first exuvial layer of vegetable mould; succeeding generations give successive increments to the soil, thus forming, from which men are to reap their harvests, and cattle to derive their food; from which hereafter forests are designed to spring, and from which future navies are to be supplied.

But how is this frail dust to maintain its station on the smooth and polished rock, when vitality has ceased to exert its influence, and the structure that fixed it has decayed? This is a point which has been too generally overlooked, and yet which is the most wonderful provision of all: the plant, when dying, digs for itself a grave, sculptures in the solid rock a sepulchre in which its dust may rest. For chemistry informs us that, not only do these lichens consist in part of gummy matter, which causes their particles to stick together, but that they likewise form, when living, a considerable quantity of oxalic acid; which acid, when by their decay set free, acts upon the rock, and thus is a hollow formed in which the dead matter of the lichen is deposited. Furthermore, the acid, by combining with the limestone, or other material of the rock, will often add an important mineral ingredient to the vegetable mould; and not only this, the moisture thus conveyed into the cracks and crevices of rocks and stones, when frozen, rends them, and, by continual degradation, adds more and more to the forming soil. Successive generations of these bond-slaves successively and indefatigably perform their duties, until at length, as the result of their accumulated toil, the barren breakers, or the pumice plains of a volcano, become converted into fruitful fields.

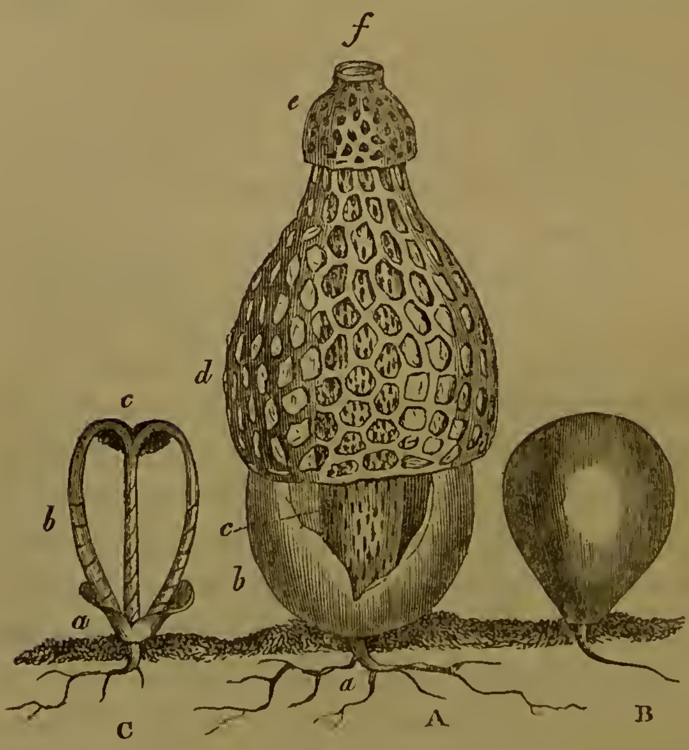
MUSHROOMS, OR FUNGI.

(55.) The Fungi form a large and very curious and important class of vegetables, differing little in the lower grades from several types of Algæ, and, indeed, often considered as of inferior rank in the general scale of creation. They are simple in their structure and rapid in their growth, and, although parasitic, for the most part grow upon lifeless organic matter, which they rapidly decompose, and speedily remove; thus making what has become useless to itself useful to its survivors. For these duties

they are peculiarly fitted by their wandering habits, whence, by Linnæus, they were figuratively called *vagrants*, or "Nomades." On weak and sickly plants these parasites abound; hence, they are often supposed, as blights and blasts, to produce the diseases they attend. They likewise flourish most luxuriantly amongst refuse matters, muck, and offal; and often in great part form what is called mustiness, mouldiness, or mildew: hence, indeed, they have been named respectively Brands, Musts, Moulds, Mildews, Mushes, Mushrooms, &c.

(56.) The botanical term *fungi* (a word which has now, very properly, become almost naturalized to our tongue,) is peculiarly expressive of the functions these plants perform, whether it be immediately derived from *funus* and *ago*, as indicative of their office, the removal of the dead, or intermediately from *fungor*, to discharge or execute a duty.

(57.) The natural history of these plants is one replete with interest and wonder, and, notwithstanding the little attention they commonly excite, they are constantly labouring for the general advantage. The quickness of their growth is astonishing, and the rapidity of their increase all but past belief. The Phalli, the structure of which is so curious as to seem almost paradoxical, extend themselves in height six inches within an hour. The Bovista, or



A. Phallus indusiatus.
a. Root.
b. Volva, or wrapper.
c. Columella, or stipes.
d. Veil.
e. Pileus, or cap.
f. Central channel, running through the plant.

B. Young Clathrus, enclosed in volva.

C. Laternea triscapa.
a. Torn volva.
b. Trifid stipes.
c. Pileus.

bull-puff-ball, has been computed to grow at the rate of many million

cells per minute, upwards of a million per second; and to be, when at maturity, so many times larger than when beginning to germinate, that figures shrink from the expression of the sum. Furthermore Fries asserts that he has counted, in a single individual plant of the smaller kinds, called smuts, 10,000,000 sporules, so subtile that they rise into the atmosphere like smoke; and hence, although lost in astonishment at their prolific powers, our wonder ceases that they should be everywhere dispersed, and colonize every spot that affords fit nutriment for their growth.

(58.) The *Fungi* are associable into three chief groups or orders. The first includes those known familiarly as blights, blasts, and mildews, called collectively the *Mucorales*, (the Hypho- and Coniomycetes of some writers); the second, the puff-balls, truffles, and other tuberiform fungi; hence named the *Tuberáles*, (Gastromyci, or Gasteromycetes;) and the third, the common eatable and poisonous mushrooms, toadstools, &c., the *Mycetales*, (the Hymenomyci, or Hymeno-mycetes, of many systems.) But of each of these in turn hereafter.

MOSSES, OR MUSCI.

(59.) The mosses, *Musci*, (using the term in an extended sense, though far less vaguely than formerly was done, when almost every thing moist and soft was called a moss,) will include in one class, along with the frondose mosses, or moss-worts (Bryales or Muscosæ), the *liver-worts* (Hepaticales or Hepatici), and the

A B

A. Jungermannia ciliaris, one of the liverwort mosses, or Hepáticales.
B. Bryum undulatum, a frondose moss, one of the Bryales.

stone-worts (Charales), orders which, although sufficiently distinct, have several important characters in common, by which they are associated together more naturally than either with any other class.

(60.) The liverworts (Hepaticales), which now are classed with the mosses, were formerly considered more nearly connected to the flags, and, indeed, by Linnæus, they were denominated Algæ hepaticæ; and the curious stoneworts (Charales) have likewise in general been separated too widely from their natural allies, whether arranged with the Confervæ or with the Ferns. From the latter they are distinguished by their simply cellular structure, and from the former by the evolution of a distinct axis of growth, around which central line various processes, as leaves or branches, are arranged. These characters associate them with the Musci, which thus exhibit, by their more elaborate forms, a further stage of vegetable development. Still it must be confessed that the Charales are apparently the least normal of the group; yet they seem to stand more fitly here than elsewhere, being an osculant or connecting link between this region and the next.

(61.) The uses of mosses are great in the general economy of nature. Well have they been called, by Linnæus, her ministers, (Servi,) filling up, as they do, and consolidating bogs, clothing mountains even to the verge of perpetual snow, and condensing the moisture of the atmosphere; thus giving origin to rills, and being the living fountains of many streams: but of their functions more hereafter.

(62.) With the Mosses, the first region of the vegetable reign concludes, in which the three classes, Flags or Algæ, Funguses or Fungi, and Mosses or Musci, are included; three classes which, although essentially distinct in the more highly developed and normal genera of each, are still, on their confines, scarcely distinguishable from each other. The simply cellular structure of the whole is their chief bond of union: in this they all agree; and future investigations will show it to be a most important diagnostic sign: hence they have been called Cellulosæ or Cellulares.

(63.) Furthermore, the fact may be enunciated that these vegetables are not reproduced by seeds, and, as they can therefore have no cotyledons or seed-lobes, they have been named Acotyledons; as stated in the tabular conspectus, [§ 21] they are the Musts, Must-allies, or Mosses, of our rustic dialects.

(64.) In most languages it will be found that these lower tribes of plants have originally had the same, or nearly similar, appellations; and that, although their names are different now, the difference often consists in a mere modification of the original term, and that all may be traced to a common root.

(65.) This etymological evidence it would not be right at present to dilate on; but one example may not be irrelevant, to show the general impression which their most obvious characters are calculated to produce.

Our word *moss* (which the Normans gave us for the older *reet*,) is derived immediately from the Gallic *mousse*, a term of exactly similar meaning, when applied to plants, but which also signifies froth or lather, and is itself a derivation of *mou*, *soft* or *loose*, like the foam of the sea or vesicles of lather; analogous to our *must* or *wort*, given to fermenting liquors, and to various similar plants. Hence also sea-weeds, many of which are called *sea-froth*, *sea-foam*, *sea-membranes*, &c., as already shown, are called by the French *mousses de mer*, or sea mosses, the *musci marini* of the older writers, the *βρύον θαλάσσιον* of Dioscorides and Pliny. Furthermore, fungi, or mushrooms, are named *mousserons*, moss-allies; which is, perhaps, a contraction of *mousseronde*, or *round moss*, i. e. soft or puff balls.

(66.) This softness of texture and cellular formation seems to have given names to almost every section. Thus, mouldiness or mustiness is called *moississure* and *mucor;* mildew, like our *mild-dew*, *serein* and *sideratio*, adverting to its supposed deposition from the atmosphere, or belief that the affected plants were star-struck; *muccdo*, *muceo*, and *mucus*, are of nearly similar import to each other, and to our muck or slime; just as *must* in *must-iness*, and *mush* in *mush-room*, are but corruptions of *moss*, or *mousse*. Hence the whole series may be well associated under the common names of *musts* or *mushes*, or *mush*, i. e. moss-allies, technically Myc-affines: their connexions are already intimated by many of their names, such as *muscus*, a moss; *muces*, *mousseron*, or *mouceron*, a mushroom; *mousse de mer* and *βρύον θαλάσσιον*, sea-weeds. Mycinema, a doubtful articulate flag, Cenomyce, and Bæomyces, genera among the lichens, with various others, show a similar affinity to be recognized by other people and in other languages, besides by ourselves and in our own.

FERNS, OR FILICES.

(67.) Linnæus, who viewed nature with the kind affections of a philosopher, and the warm imagination of a poet, gave to the ferns (Filices) the figurative name of *Novaccolæ*, or *new settlers;* and no synonyme could more happily express their habits and general importance. For barren tracts are colonized by ferns long before many other tribes could vegetate thereon; and on sterile soils, where other plants would perish for want of food, the hardy ferns find sustenance enough; consequently, in such situations they flourish and abound, unmolested by loftier and more luxuriant shrubs and trees.

(68.) Ferns are truly colonists, and to fit them for the migrations they are destined to perform, it would seem as if nature, even while developing their organs of vegetation, and giving them both shrubby and arboreous stems, had considerately restrained an equivalent evolution of the reproductive system, lest they should be encumbered by weighty seeds in their successive and continued transits over large tracts of land, and in crossing extensive seas.

A. Cyathea arborea, a tree fern, round which twines

C. Polypodium crassifolium, a scandent fern.

B. Asplenium rhizophyllum, an herbaceous fern with rooting fronds.

D. Equisetum fluviatile, a jointed fern.

E. Lycopodium cernuum, and

F. ——— phlegmaria, suffruticose and trailing ferns.

(*Dict. des Sciences Nat.*)

Hence, instead of elaborate fruits and seeds, ferns, with the stems and nearly the foliage of palms, have spores little differing

from those of mushrooms and of mosses. Like them, they are most prolific, for a single frond, and one fern bears many fronds, has been computed to produce upwards of a million spores.

(69.) Like the musts and their allies, so minute are the reproductive spores of ferns that their existence was even for a long time doubted, and before microscopes exposed them to our sight, this belief was common, and many references are made to it in our older writers. Shakspeare, in allusion to this then popular opinion, observes, " we have the receipt of fern-seed, we walk invisible."

The final cause of this reduced development appears to be, that such dust-like spores should be easily transportable from place to place; and hence it is that barren heaths, and coral rocks, and new made islands, raised probably by submarine volcanoes, after that lichens and mosses have first subdued the sterility of stone, are colonized by ferns, the heralds of a more luxuriant vegetation, and harbingers of plants more immediately subservient to the purposes of man. And not only is such the course which nature now pursues in the conversion of barren into fertile soils, but geology informs us that such was the scheme of her primæval operations in preparing the earth for the reception of man; for, from the strata in which ferns are found, it is more than probable that they preceded and prepared the way for the introduction of many other vegetables, for the higher animals, and for the human race.

(70.) The peculiar characteristics of the several groups of moss-like, jointless, and jointed ferns, must, from the limits to which an introductory sketch is of necessity confined, be reserved for subsequent explanation; but this need not be regretted, for, as the illustrations successively become more and more familiar, they will of course require, in this bird's-eye view, a less and less elaborate description, and for some a mere nominal reference will probably suffice.

(71.) Hence, the grasses and the sedges, the lilies and the palms, the pines, &c., although much more important plants, as ministering more immediately to the comforts and conveniences of man, will, from their being so much more familiar to all, require far less descriptive detail, than the lower classes of mosses, flags, and fungi; many of which are comparatively so little known, and which seemed, therefore, to demand in this preliminary conspectus, the most particular introduction.

GRASSES, OR GRAMINA.

Saccharum officinarum, the sugar cane; one of the grasses.

C. A. B.

D.

A. An entire plant diminished. B. Spikelet of flowers. C. A flower separate. D. Ditto, opened to shew the stamens and pistils.

(72.) The grasses and sedges, though in some features similar to the shave-grass ferns, are as characteristically distinguished by the higher development of their organs of reproduction, as the ferns are by that of their organs of nutrition. In this class it is, that true flowers are first observed, and the fruit no longer developed as spores, but in the form of *grains*. Hence they have been named by some botanists, in reference to their fruit, *Graniferæ*; by others, referring to the husks within which their flowers are found, *Glumaceæ*; and by others again, from their stalks, which are called straws or culms, *Culmiferæ*.

(73.) The grain-bearing, husk-flowered, or straw-stalked plants, of the Botanist, are the grasses and sedges of the farmer. But as these, including in the first-named the cereal species or corn, can no longer be referred to the single *genus Gramen*, GRAMINA should either become the name of the whole order, or, should this seem objectionable, they might be called collectively SEGETES, or *Grassedges*, (Gracarices,) thus avoiding the periphrases Gramina et Carices, Grasses and Sedges; Plantæ Glumaceæ, P. Graniferæ, P. culmiferæ, and so forth.

(74.) The *grasses* pass by the *reeds* and *canes* to the *palms*, the *rushes* and the *lilies*; the *Palmæ* et *Lilia* of the Linnæan scheme; both of which are included in the *Palmares* of our scale.

PALM-LEAS, OR PALMARES.

A. Areca catechu. B. Musa paradisiaca. C. Agave geminiflora.
D. Iris germanica. E. Narcissus poeticus.

(75.) This class, *Palmares*, contains some of the most curious, splendid, and majestic plants existing, which Linnæus called the Princes (*principes*) and Patricians (*patricii*), while he denominated the grasses the Plebeians (*plebeii*) of the vegetable kingdom. The tulip, iris, orchis, and banian types are the pride of our gardens and conservatories; and the palms, although insignificant when grown in our largest houses, still shew, even in confinement, what majestic plants they must be when flourishing unrestrained in the wild luxuriance of desert nature: for some, with erect stems, attain the height of nearly 200 feet; and others, that are climbing palms, are found of 500 feet in length.

(76.) The three classes forming this, the second region of the vegetable reign, include plants possessing a very peculiar and characteristic structure; which, although pervading all, is thought to be (though, perhaps, not altogether correctly) more decidedly developed in the palms, than in the arboreous ferns, the grasses, the sedges, or any of the other sections.

(77.) This structure will hereafter be fully explained, but even now the fact may be enunciated, that anatomical investigations,

in the first place shew, that these plants consist not of cells alone, as in the mosses, funguses, and flags, but of tubes and cells, more or less irregularly collected into fasciculi, which are dispersed in general without reticulations in the leaves, and deposited centrally within the stems. That the stems are covered externally by the squamous remnants of the successive crops of leaves, just as the bulb of a lily is by its scales; that the oldest growths are likewise, as in the bulbs of the lily, tulip, onion, hyacinth, &c., external; and the newer growths mostly internal; so that the parts first formed are gradually forced outwards and distended, until they become so far indurated as not to yield further to pressure from within. Hence, when this hardened girth has once been formed, the stems never after increase in thickness, how much soever they may increase in height.

(78.) From this law of evolution a very important character results; for, as the stems in general can never increase in girth, and the successive crops of fruit and leaves can only be supported by maintaining a communication with the roots, by successive internal deposits of adducent and reducent vessels; so when the first formed cylinder is filled with fibres, year after year condensed, a period at length arrives when, the internal space being filled, no further deposits can take place; and the plants inevitably die. This period is of greater or less extent in different species; but, however great it may be, a limit is fixed in early life to their duration, beyond which they cannot pass. Life being to them but a preparation for death; and the very means by which they subsist, renders their extinction progressively more certain.

(79.) In different palms the diameter thus first formed varies, and the height to which they grow is various likewise; but to whatever extent either may proceed, the one is decidedly the limit of the other; for every additional bud or crop of leaves depositing its fibres in the centre of the stem renders the mass more dense, and more and more confirms the outer ring, which, when filled, will permit no further fibres to descend, and the plant, without redemption, dies: should, however, this cylinder be cut through, or by any means be burst, then the term of existence may become indefinitely extended; and such is the case in the Dracæna; and the celebrated one in Franqui's garden, in the island of Teneriffe, is probably six or seven hundred years of age.

(80.) The general mode of growth being thus internal, has caused the whole region of plants in which it is found to prevail to

be called *Endogenæ*, or inside growing vegetables; as the previous region, from their cellular structure, have been called cellulosæ, or *Telogenæ and Syngenæ*. The term of their existence being fixed during their earliest years, which the very act of growth renders more and more inevitable, and which is strengthened by their strength, may not improbably have led the ancients to apply the name *Termes* to a palm-tree, as well as to the fruit branches of other plants, when plucked, and a period put to their existence: and hence the region in which this peculiar characteristic is found to prevail may be called TERM-AFFINES, as indicative of this, one of the most notorious diagnostic signs.

(81.) Experiments have shewn that some bulbous plants, when freely supplied with water and with abundant food, produce more leaves than flowers, and not unfrequently the blossoms entirely fail: nor is it, until the supplies become diminished, that either flowers or seeds are formed. This is a matter of experience; and gardeners avail themselves of the knowledge to force unwilling plants to blossom, and barren trees to bear. A somewhat similar phenomenon is observable among certain palms, and may not improbably be accounted for on similar principles. For example, the Talipot, with its majestic columnar stem, equalling in height the main-mast of a man-of-war, and bearing annually, through ages, its royal crown of gigantic leaves, never flowers but once. The foliage is luxuriant in the extreme, one leaf being sometimes five and thirty feet in circumference and large enough to cover thirty or forty men: and this very luxuriance in leaves is probably the cause of its continued barrenness in flowers. But towards the close of its existence, and when the stem has become so far indurated that fresh ducts from the terminal buds cannot readily descend,

Corypha Umbraculifera.—The Talipot Palm.

when the supplies of food are curtailed, and its last effort to live brings inevitable death; then the *Corypha* blossoms and its beautiful flowers which smell so strongly that they can be perceived at a great distance, are succeeded by an abundant crop of fruit; one tree yielding enough to supply an entire country: and thus the Corypha, after having lived so long for itself, dies for its posterity.

(82.) It rarely happens among the palms, and not frequently amongst any of the *Term-affines,* that more than the central bud is developed; and hence these plants are seldom branched; and their trunks, when elevated, and no longer creeping stems (rhizomata), are for the most part cylindrical or nearly so. There is no absolute necessity, however, for this abortion of the lateral buds, and hence, occasionally an extra one is developed and forms a branch. In some, as the Theban Doom-palm, (Cucifera thebaica or Hyphæne coriacea,) two buds are naturally and equally developed, so that the stem becomes repeatedly forked (bifurcate.)

(83.) In certain grasses likewise, as the bamboos, the stems are branched, and various exceptions to the general law are known, which hereafter will be detailed, and which circumstances render *Term-affines* a preferable name to *Termites,* the use of which, moreover, is now forbidden from its being appropriated by zoologists to a destructive tribe of ants; and far preferable to either Monocotyledones or Endogenæ, as they are not universally either one-lobed or inside-growing plants.

ZAMIAS AND PINES, ZAPINI.

(84.) *Zamiæ,* or *Zemiæ,* names given by the ancients to the cones of firs, which, being left to open ungathered, they believed to injure the trees and lessen the following crop, have in modern science been devoted to the designation of several curious plants, which, with their allies, the Cycases, connect, by their habit the *Ferns* and *Palms* of the *Term-affines,* with the *Pines* and forest-trees, to which, by their internal structure, they are found to be legitimately allied.

(85.) Hence this first class of the third region, including the *Zamiæ* and *Pini,* may, to avoid a periphrase, be called *Za-pini,* and the two orders it contains, the *Zamiales* and *Pineales.*

A. Abies excelsa.
B. Thuja pendula.
C. Cycas circinalis, male.
D. ———————— female.

(86.) The naked seeds and peculiarly porous wood-vessels, which so closely associate these plants, otherwise at first sight apparently dissimilar, are characters but comparatively a short time known; and therefore, previous to their discovery, the Cycases and Zamias were arranged by some authors with the Ferns, on account of their gyrate vernation,* and by others with the palms, on account of their simple stems.

(87.) But the internal structure of these plants differs greatly both from the Ferns and from the Palms, for although not to the fullest possible extent confirmed, still their growth and annual deposits are decidedly external; they increase in thickness, and the layers of vessels which constitute their wood are stratified, each succeeding year external to those of the preceding; a character which is common to this region, and which forms a strong contrast with the internal growth of the *Term-affines*.

(88.) Hence the plants in this region increase in girth as well as height, and have no determinate period assigned for their duration. These circumstances are indicated by their collective name, *Cres-affines*, or *cress-allies;* and among them will be found examples of the tallest, the largest, and the oldest vegetables existing.

(89.) From the external growth and exterior deposition of wood, these plants have been likewise called *Exogenæ*, or *outside*

* Curling inwards of the leaves or fronds as in Cyathea, vid. page 18.

growers, and they have also had other names indicative of other characters, to which reference shall be made hereafter.

(90.) Zamias and Cycases, neither being indigenous to this country, nor naturalized to our climate, Firs, Larches, Yews, Cypresses, and Cedars, are among the most familiar examples of the first class of the Crescaffines, which is distinguished from the succeeding, not only by the peculiar structure of the wood, but also by the seeds being naked, i. e. not furnished with an especial covering or seed-vessel, as in the following group: hence their descriptive synonyme, Plantæ gymnospermæ; but as this term has been otherwise, though generally incorrectly used, and, as it is not applicable to these plants alone, perhaps a name compounded of the appellations of the most important genera and orders it contains, may be esteemed more fit to designate the class, such as Zapini, *i. e.* Zamiæ et Pini, as before observed.

By some the *Zamiales* have been called *Cycadeæ*, and the Pineales, *Coniferæ;* but both orders are equally coniferous, while the latter does not include universally cone-bearing plants; hence this is a collective rather than a distinctive term, and as such it has been used, although disadvantageously by others: and therefore it is now proposed to supersede it by the compound appellation above described.

(91.) Pines, which rank among our loftiest trees, are seldom known in this country to exceed a hundred feet in height, such plants are not to be compared with the magnificence of the New Zealand and Canadian species, which tower from one to two, and even to three hundred feet in height, maintaining at the same time a proportionable girth. One tree, indeed, I have had an account of, which grew in New South Wales, which is said to have exceeded 400 feet in height, being higher than the cathedral of St. Paul, (but not being a pine it should rather be mentioned when treating of the succeeding class, were it not as well to collect the chief of the crescaffines together,) and we are told that an American cypress is now existing that measures above a hundred feet in girth.

CRESSELS, FRUGES, OR EUCARPÆ.

(92.) The Herbs and Trees (Herbæ et Arbores) of Linnæus, figuratively called by him the Nobles and Elders, (Nobiles et Proceres,) of the vegetable kingdom, and amongst which he distinguished those bearing arms (such as thorns and prickles) as

Warriors (Milites) that not only thus defend themselves, but also protect otherwise defenceless vegetables from the aggressions of animals, were collectively denominated by Hill, Plants or Plantæ, under which common name he included all those species which were not reducible to any of his six previous classes, Fungi, Algæ, Musci, Filices, Gramina, et Palmæ.

(93.) But the plants of Hill, thus negatively defined, formed such an extensive group of faintly characterized and heterogeneous sections that the term *plant*, instead of being restrained even to the extent that he designed, has long been used as a synonyme for vegetable; and the herbs and trees both of Linnæus and the older writers, are so inseparable, and (as systematic groups) so ill-defined, that the words are now indifferently employed, in almost every class, merely to distinguish the larger and perennial, from the smaller and more transitory species.

(94.) Hence reformation was greatly needed here, and the group has been entirely remodelled and recast; many sections have been excluded, and other arrangements made. But, notwithstanding these exclusions, the class still remains very large; yet, though extensive, it is now well characterized and easily defined. For the seeds, instead of being naked, as in the Zamias and the Pines, are invested with a peculiar covering called a pericarp, or seed-vessel, and known commonly as the fruit; such as the fleshy part that is eaten in the melon and the peach, the shell or pod that is thrown away in the nut and the bean. Hence by some botanists these vegetables have been called *Exogenæ Angiospermæ*, or *seed-vesselled*, to contradistinguish them from the *Exogenæ Gymnospermæ*, or *naked-seeded plants*. Richard and Bartling, who regard other characters as more distinctive and important, call them *Exorhizæ* and *Gymnoblastæ*. But we had rather name them, with special reference to the high development of the fruit and seed, *Fruges*, or *Eucarpæ*. Indeed, this latter change seems necessary, from the exclusion of the plants which form our seventh and ninth classes, which we think improperly blended, whether with the Angiospermæ, Gymnoblastæ, or Exorhizæ, by the botanists who use those names.

(95.) The gymnospermous Pineales being excluded on the one hand, and the evascular Rafflesias on the other; the *Eucarpæ* or *Cressels*, much as they may differ, and much as they do vary in size and in duration, are mostly coincident in their radiate and stra-

tified structural arrangement; and all in the exogenous disposition of their tubes and cells, by which characters they are distinguished from the *Selanthi;* and in the constant development of a seed-vessel at some period of their growth, by which they are known from the Zapini.

(96.) Amongst the *Fruges*, or *Eucarpæ*, are found many of our culinary vegetables, known commonly as cresses, and some of the most elegant of our garden plants: hence, as a distinction, they might familiarly be called *cressels; sel*, as in *sel*ago, ground*sel*, &c., indicating worth or beauty.

(97.) To illustrate plants so well known seems almost a work of supererogation; and yet not to cite examples from such an important and extensive series, might appear to be unpardonable neglect.

Although agreeing in their common and essential characters, in no class is there exhibited a greater diversity in the subordinate developments and the secondary modifications: and hence these plants are distributable, and have been distributed, into very numerous types and sections. These will hereafter be described; it is the general character of the classes and the regions that, in this introductory subjective outline, we chiefly desire to illustrate.

Let, therefore, the Oak, the Chesnut, and the Baobab, as being

Golyno's Oak.

the most familiar and noble, serve now as sufficient illustrations. For these, besides by their covered fruits exemplifying the class,

will, with the fir, the yew, and the cypress of the Pineales, mark most strongly the all but unbounded size to which the *Cresc-affines* may increase, and the almost indefinite term of their duration.

(98.) In my "Amænitates Querneæ," I have collected many records of extreme size and age in trees, especially in oaks; several of these are British, and some are still existing. Perhaps the Tortsworth, the Salcey, the Allouville, and the Cowthorpe are the most interesting and curious examples. The first-named measures fifty-two feet, the second forty-six, and the last, at its lowest level, seventy-eight feet round. Baobabs, however, have been described still larger: Adanson measured several varying from seventy-four to seventy-seven feet in circumference; and Perrottet and Golworthy mention having found them of ninety, and occasionally even exceeding one hundred feet in girth.

(99.) The ages of several European trees, especially chesnuts and oaks, have been satisfactorily traced by records through many centuries, and of that of others a fair estimate can, in some cases, by other means be formed. Thus, the old chesnut of Tortsworth is known to have numbered above seven hundred, and is calculated to have lived upwards of a thousand years. The age of the Salcey oak has been computed at above a millenium and a half; the oak of Allouville is believed to be between eight and nine hundred years of age; and the Cowthorpe oak is probably more than twice as old. But what then can be the probable age of the still larger Baobabs?

(100.) Of the natural history of these enormous plants too little is at present known to allow any positive deductions to be drawn from their size alone: but still calculations have been made, although not on wholly unexceptionable data. It is with the *degree*, however, that I am less satisfied than even with the *kind* of evidence adduced. Furthermore, I do not think that the observations have been made with sufficient care: for trees increase very irregularly in the several radii of their diametric bulk; and if three hundred rings, measuring, say three feet across, be granted to be the produce of three centuries on one side of a certain tree, and that an injured or wounded side, this fact alone cannot warrant the conclusion that three feet of the diameter measured on the other or unwounded side, or in another tree, have likewise been three hundred years in forming.

Adansonia digitata.—The Baobab.

We do not mean to say that the evidence is bad in principle, but that not enough has been afforded for reducing it to practice; and yet on such evidence it is by some botanists of celebrity asserted, that the smaller Baobabs are a thousand, and the middling-sized ones above two thousand, years of age; and hence, forsooth, that the largest which have as yet been found (exceeding one hundred feet in girth,) must have lived for upwards of fifty centuries at least. The portrait of one of these majestic Baobabs, which is given in Macartney's Embassy, whence the accompanying figure has been taken, is one of those upon which some such calculations have been founded; and yet it would seem from its geminate trunk, to be an instance of all others peculiarly unfitted for generalization.

(101.) But however this may be, it is for the purpose of our present illustrations, a matter of comparatively little moment: for, whether the Baobabs have numbered quite so many years as their admirers contend or not, their antiquity, doubtless, is extreme, and their sturdy dwarfish stature, as they seldom exceed sixty or seventy feet in height, must favour their almost indefinite duration. Their age, even at the lowest computation, will form a striking example of that one great characteristic of these plants and their allies, the structure of which sets naturally no limit to their existence: and hence it is that they have been called the *Cress-allies*, or *Cresc-affines*.

(102.) It must not, however, for a moment be supposed that all the plants included in this region are essentially so long-lived, for

many are quite ephemeral; but, however long or short a period they endure, their structure is similar to that of the most long-lived species; and, unlike those included amongst the Termaffines, there is nothing in their mode of growth physiologically incompatible with indefinite duration. But it is time that some further account be given of the examples already cited.

(103.) Seven hundred years ago, the "great chesnut of Tamworth" was referred to in writings still extant, as a signal tree; and if, in the reign of King Stephen, A. D. 1135, it was called *the great chesnut*, it is more than probable that it has bounded the manor of Tamworth (now Tortsworth,) for upwards of a thousand years. Some time since it measured fifty-two feet in circumference; and, from calculations that have been made, it is believed that in its youth it must have been contemporary with the Saxon Egbert. I have lately made inquiries concerning the state of this venerable tree, and learn, with satisfaction, that it is not only still alive, but flourishing in its "green old age," and, from the vigour its shoots evince, it will probably outlast the present generation.

The accompanying figure is of a chesnut of still more enormous growth, and probably of still more lengthened years: it is the celebrated Castagno di Cento Cavalli, the monumental ruins of

which still exist on Etna. A traveller of credit reports this tree to measure, round those isolated parts, which were evidently once in union, a hundred and sixty feet. So capacious is the cavity of

its enormous shell that the peasants have built a house within it, where they have an oven for drying chesnuts and other fruit; and, with an ingratitude which, however, is not without a parallel, they often supply themselves with fuel from the sylvan patriarch that surrounds and shelters their abode. By some persons this chesnut is said to have been capable of containing, or rather perhaps of overshadowing, a troop of a hundred horsemen; and it is reported to have received its name of "the hundred-horse tree" from having afforded shelter to Jean of Arragon, and her attendant nobility, amounting to that number, who were overtaken by a storm on Etna. It is well known that she passed some time in Sicily, on her way from Spain to Naples. But it is not improbable that the word *cento* is here employed indefinitely, as *forty* was by the Jews, and *score* still frequently is by us, to express a *multitude* or *many*, rather than any precise or definite number.

(104.) The oak of Allouville, in Normandy, known there as the *Chêne Chapelle*, and to which reference has been made, was, above a century and a quarter since, converted into a place of worship. Its trunk was at that time hollow, and its head in part decayed. This living cavern was then paved and roofed, and divided by a floor into two apartments: the lower was fitted up by the Abbé du Détroit as a chapel, and the upper as a chamber for the officiating priest; who thus, like a second Stylites, might dwell aloft in the wilderness alone.

(105.) The caverns in hollow oaks are, however, seldom devoted to such honourable purposes: that in Damery's for years was used as a tavern; in the prison-oak at Kidlington, vagrants and other slight offenders are said to have been occasionally confined; and the shell of the venerable Salcey patriarch, which is nearly half as large again as the chapel-oak, was formerly enclosed by gates on either side, and cattle penned within it; and so capacious is the hollow of the Cowthorpe oak, that upwards of seventy persons have been, as the villagers affirm, at one time therein assembled.

(106.) Were it not, as I elsewhere have observed, for instances such as have now been mentioned, (some of which occur in our own country, and in our own or our fathers' time,) we might almost be allowed to treat as fables the tales of modern travellers, who tell of trees converted into tanks, and tombs, and prisons; as well as those older histories, which declare that the ancient Germans made castles of oaks; that in one vast cerrus a hermit built his cell and

chapel; and that another "served both as a castle and a fort." Of these stupendous oaks the history would almost seem to be as monstrous as their reported bulk; but that a hollow oak might be sufficiently large for a hermit's cell and chapel, we have existing proof in the oak of Allouville; and it may be also well conceived, when we reflect that the cavity in Damery's oak was three feet wider than the parish church of St. Lawrence, in the Isle of Wight; and that the trunk of the Cowthorpe oak, just noticed, where it meets the ground, stands on a plot exceeding by more than six feet the length, and by two feet twice the width, of the parochial church just mentioned.

(107.) Few persons, indeed, save those to whom habit has rendered it familiar, form any thing like just estimates of the actual size of trees. The situations in which they commonly are seen, harmonizing with the illimitable expanse of heaven, and the wide extent of forest scenery or of mountain heights, lessen ideally their apparent bulk: nor is it till singled from the surrounding landscape, nor even then, until the theodolite and rule proclaim their sums, that we become persuaded of their vast extent. Nay, figures themselves, to the generality of the world, convey but very imperfect conceptions of length, and breadth, and height, and girth: some more familiar representations are wanted to prove that a majestic tree, which is only in moderate proportion as an ornament to nature in the country, is really an enormous mass, and would be esteemed a large and glorious structure amongst the dwellings and palaces of men, in town. It is by comparing these forest kings with more homely objects, that we alone become acquainted with their correct capacity. When seeing an oak seven feet in diameter, its size arrests not our attention; we even pass with little thought such as hold ten or twelve feet across, or more, although the smallest of these has a width as great as the carriage-way of Fetter lane, near Temple bar, or of Bedford street, in the Strand. Oaks could be named which would suffer two broad-wheeled waggons to pass each other on the kerf; the stub of one has been described on which two men could thresh, without incommoding each other; and this was not one of the largest size. The chapel-oak of Allouville, not half so large as our Cowthorpe tree, is of equal size with the famous Greendale oak, the trunk of which is pierced by a road, over which it forms a triumphal arch, higher by several inches than the entrance to Westminster Abbey

(the Poet's Postern), and under which men on horseback pass, and through which carriages have been driven.

(108.) The area occupied by the Cowthorpe oak, where the trunk enters the soil, exceeds the groundplot of that majestic column, of which an oak is confessed to have been the prototype, viz. Smeaton's Eddystone lighthouse. Sections of the stem of the one would, at several heights, nearly correspond with sections of the curved and cylindrical portions of the other. A chamber of equal extent, or larger than either of those in the lighthouse, might be hollowed out of its trunk; the natural caverns in Damery's and other oaks were larger than the chambers alluded to; and transverse slices of the stem would be considerably too large to floor any of them. Arthur's round table, which is a plank from such an oak, would form for it an entire roof, or projecting capital: indeed, upon this table there might be built a round church, as large as that of St. Lawrence before referred to, and space to spare; so that, if the extent of the sapwood were added, or the groundplot of the Cowthorpe oak were substituted for the table, there would be plenty of room, not only to build the parish church, but also to allow enough for a small cemetery beside. Indeed, with reference to this last-named oak, and also the tree-castles and tree-chapel, I would merely observe, that St. Bartholomew's, in the hamlet of Kingsland, between London and Hackney, which, besides the ordinary furniture of a place of religious worship, viz. desks for the minister and clerk, altar, staircase, stove, &c., has pews and seats for one hundred and twenty persons; upwards of one hundred have been in it at the same time; and some months since, myself made one of a congregation there assembled of nearly eighty persons, (seventy-six or seventy-seven were counted,) when the pews were by no means crowded, and plenty of room left vacant. Still this chapel is nearly nine feet less in width, and only seventeen inches more in length, than the groundplot of the Cowthorpe oak: in fact, the tree occupies upwards of thirty square feet more surface than does the chapel. Or, to take another illustration, in Little White Lion street, Long Acre, the inspectors of a district visiting society found, some months ago, a house, the internal area of which is only twelve feet by twenty-four, (not half that of the Cowthorpe oak, which is twenty-six feet in diameter,) containing nine small rooms, in which there dwelt—i. e. eat, drank, and slept, and did all that poor mortality requires,—no less than eleven men,

thirteen women, and sixty-nine children, making a total of ninety-three human beings, who have been crowded into less space than is enjoyed by a single tree, (Amænitates Querneæ.)

SELWORTS, OR SELANTHI.

(109.) The next and concluding class is formed by the *Selanthi*, or *Selworts*. These plants, like the *Pineales*, were until lately blended, some with the Fruges or Eucarpæ, and others with the Palmares; but, although still less in number as yet are known, those which have been discovered and examined constitute a group as structurally distinct, or more so, than even the Zamiæ and Pini; for, in the Selanthi, the vegetable kingdom, after proceeding through many successive stages of development, from seedless to flowering plants, exhibits a return to the point whence the series of evolutions began. They seem, in fact, to form the descending links which connect the highest with the lowest grades of vegetable development.

(110.) By their flowers, sometimes evolved in a most exuberant degree, they establish their connexion with the highest flowering plants; while, by their destitution of tubular vessels, and their frequently fungoid characters, they show their close affinity to the lower mushroom sections.

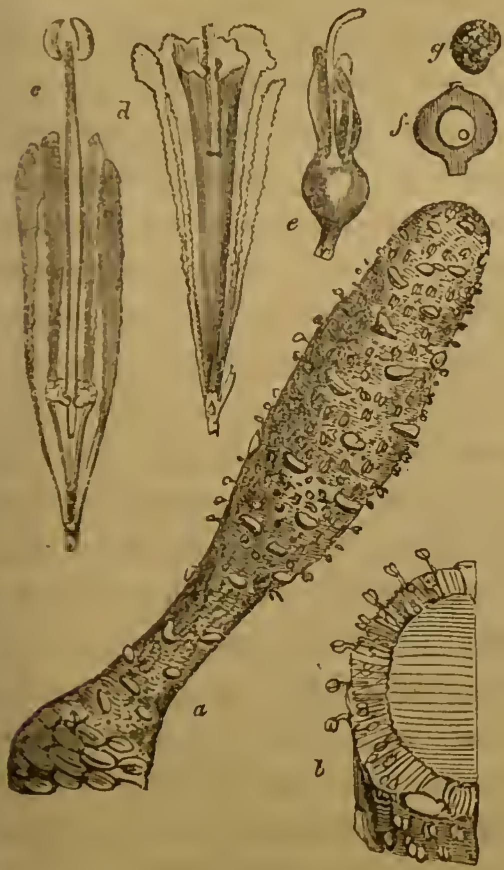
(111.) Some of these plants, such as the Cytinus, &c., have long been known, and, from their paradoxical structure, regarded as anomalies and exceptions in the classes to which they were formerly referred. But the most splendid of the group, and that which alone would justify their collective name of Selworts, or Selanthi, was only discovered in the year 1818, by Dr. Arnold, the naturalist, who accompanied Sir Stamford Raffles in one of his journeys into the interior of Sumatra: it is said that the natives call it *Ambun Ambun*, or *Krûbût*, i. e. *the great flower;* and it is, in truth, a vegetable Titan. The specimen first found by the lamented Arnold, (in remembrance of whom, and likewise of Sir Stamford Raffles, it has been called the *Rafflesia Arnoldi*,) measured *a full yard across;* the petals being twelve inches long and a foot apart from each other: the nectary, adds the Doctor, (in an unfinished letter to a friend, which was published posthumously,) would, in the opinion of us all, hold *twelve pints;* and the weight of this prodigy we calculated to be fifteen pounds.

(112.) Several other allies have since been found, some of which are figured by Blume, in his "Flora Javæ," but none have been as yet discovered that equal Arnold's flower in bulk.

(113.) All these curious plants agree in several particulars. In the first place, they have no proper roots of their own, and they derive their nourishment from the vegetables on which they grow; in the second, they have no stems, the flowers being sessile on the vines that bear them; thirdly, they are destitute of leaves, the blossoms being covered only by scales, which are purplish or brownish, and resemble the chaffy scales of other parasitic plants; for, as they derive their nourishment already prepared by the leaves of another vegetable, they do not require any foliage of their own: so that here we have plants consisting of flower only, neither root, stem, nor leaves, being truly present; and what seems still more curious is, that, although the largest and most magnificent flowers in the world, they have very little in common with other flowering plants. They have no proper seeds, but are multiplied by spores, similar to the spawn of mushrooms; to which, indeed, their general form bears no slight resemblance. The petals are of a mushroom-like substance, and smell like *tainted beef;* and in them flies deposit their eggs, as they often do in fungi. Again, they contain no tubular or spiral vessels, like most other flowering plants, but consist of cells alone, like the mushroom tribes; they also spring from beneath the bark of the Cissus, which becomes gradually enlarged by their growth, somewhat resembling that false covering which several of the fungi have that grow on living plants; raising the outer surface into tumours, and bursting it as they become

more fully developed; such as the blight and blasts of corn, and so forth. Thus these stupendous flowers, which are from six to nine feet in circumference, show a likeness to the most lowly of the mushroom tribes, many of which are so minute as scarcely to be visible to the naked eye.

(114.) The *Helosis*, the *Balanophora*, and the *Cynomorium*, or Fungus Melitensis, formerly guarded with such jealous care by the knights of Malta, and sent by the grand master to all the friendly



(*a*) Entire plant, reduced, and separated from its parasitical connexions.

(*b*) Transverse section of the spadix, or club-shaped axis, to show the crowded arrangement of the flowers.

(*c*) Staminiferous flower, detached.

(*d*) Ditto, later stage.

(*e*) Pistilliferous flower, shewing the enlarged inferior ovary.

(*f*) Section of fruit, shewing the globular albumen and embryo.

(*g*) Seed, with endorhizous embryo.

[From Richard's monograph in *Mem. Mus.*]

Cynomorium coccineum *olim* Fungus melitensis, or Mushroom of Malta.

sovereigns and potentates of Christendom, as one of the most precious offerings he could make, may be cited as further examples of this extraordinary group. So fungus-like are some of these vegetable paradoxes, that they have been commonly considered such. The names imposed upon the former not improbably allude to some supposed retrogression towards the clavate forms of many Sphæriæ, or the club-shaped growths of the Clavariæ; and the latter especially has long been known as the *Maltese champignon*, or *mushroom of Malta*; and, were it not for the development of stamens and pistils, the propriety of changing the name, and disturbing the old arrangement, might admit of being questioned.

As it is, the characters will fully justify their segregation as a class from other flowering plants; the higher grades of which are by them allied to the lower flowerless and leafless sections.

(115.) Thus having traced the gradual evolution of the vegetable organismus, from the simplest of the flags and fungi, through some few of the numerous stages of development which characterize the several orders and regions of the vegetable reign, to the plants included in this final class, the present conspective sketch is closed; for they here descend towards those with which the series was begun; and, connecting the extremes of an extended scale, declare that however, for convenience, art may reduce the productions of nature to isolated groups, and divide them into separate sections, still that they are divisible by art alone; and, although relatively distinguishable, they are not absolutely separable; for, however diverse the distant members may appear, they are all intimately connected and essential to each other, and form, in their respective subordinations, but integral parts of one majestic and harmonious whole.

(116.) This bird's-eye view of the vegetable kingdom, thus condensed into the form of an introduction, has, of necessity, been very brief and general. It was, indeed, intended to be nothing more than an index or an outline, a preliminary sketch or diagram of the several chief departments that are recognized or easily recognizable by all. But slight as this prefatory notice of the several classes purposely has been, here our conspective view must cease: the plan forbids more copious demonstrations; nor are they needed, as hereafter each class must be examined separately and in detail. Still it is hoped that the end proposed has been attained; viz. the proof, by actual illustrations, of what "a varied thing" a vegetable is.

OUTLINES OF ALGOLOGIA.

(117.) Chaos, the refuge of ignorance, has ever been a favorite speculative beginning, whence men, in their presumption, have set out to create the world, and whence they would derive the origin of all things in it. But to nature, confusion is unknown; all her works are done designedly and in order. It is human weakness that alone confounds well-regulated phenomena, and forms a seeming rude and undigested mass, in which method still prevails, although unseen; the supposed disorder being order not rightly understood.

(118.) To such a chaos, as to their beginning, vegetables once were traced; and from such a source the simplest were supposed to spring: hence they were named Chaodinæ, or *Chaotic* plants. But since knowledge has enlightened the region which ignorance formerly obscured, it has been shewn that their origin and growth were never lawless, though the laws of their production were long unnoted, and may remain longer still, in part, unknown.

(119.) One form is even now, by some, retained in this so-called chaos of the vegetable world. The others, and they were many, have, as their histories were learned, been gradually reduced to their proper stations; and this, which seems still obscure, is chiefly so, from its resemblance to the early states of several kindred Algs, of which it may be probably only an abortion. Hence the propriety of its chaotic tenure is more than questionable; for, if a distinct and independent plant, it should commence the Nostoc series, [vide § 149]: if merely a rudiment or abortion, as soon as its connexions can be traced, its natural arrangement will be ensured.

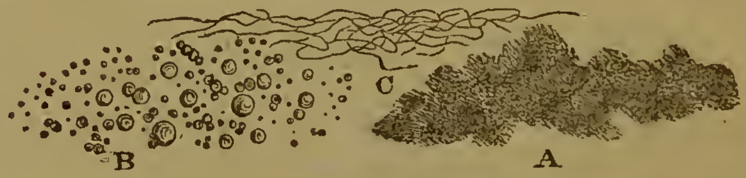
(120.) With this doubtful substance, which is a slime-like jelly, abundant in various places, especially in damp situations, and more particularly in stagnant water, the ascending synthesis begins; for in it, or in a similar nidus, the Algæ in their earliest states are found. It has therefore been called the *matrix*, or mother of the flags; technically, *Phycomater.*

(121.) This phycomater, or primitive nidus, is more or less evident or obscure, and more or less permanent or transitory, in the various groups of Algæ, to which it therefore becomes an index, affording, under the name of *thallus*, some of their most obvious distinctive signs.

(122.) Those plants in which it is evanescent, or obscure, are in appearance the simplest in their structure, although it is probable, as will immediately be shewn, that the humblest protophytes are those in which it the most abounds.

CONFERVALES.

(123.) The simplest forms of decided vegetables known, and some of the simplest which it is conceivable can exist, are cells and threads of various shapes and sizes, which abound in stagnant pools: they have been called by Turpin, from their round and

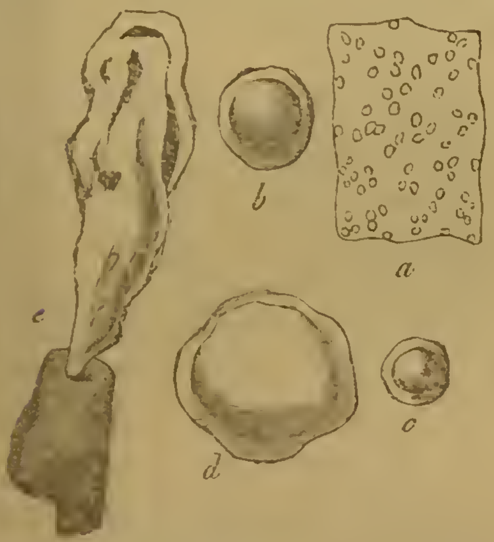


A. Protospheria simplex, simple spherulet, natural size. B. Ditto, magnified. C. Protonema simplex, simple thread-reet.

elongated forms, *Protospheriæ* and *Protonemata*, respectively. Others, a little more advanced in structure, he has denominated Globulines, [vide § 28.]

(124.) Threads and vesicles, similar to those which constitute the Protospheriæ, Protonemata, and Globuliniæ, in which plants they are apparently free, are often found suspended in, or springing from, a slime-like nidus, analogous to the Phycomater already named, and are then, in common with the slimy films or masses, known vulgarly on land as "flowers of heaven," "dead Will-o'-the-wisps," or "fallen stars;" and when noticed in water, they are frequently mistaken for, and denominated, *scums*. *Palmella cruenta* or *gory dew*, [§ 44, 132,] and *Nostoc cæruleum*, or *flower of heaven*, [§ 42, 149,] are examples already described. Palmella

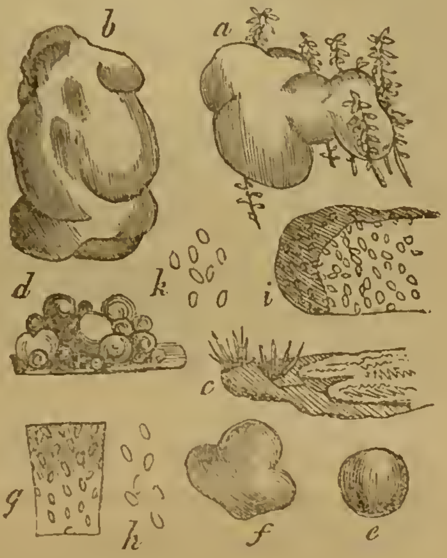
ıyalina, and P. protuberans and botryoides, are further illustra-ions; the former being an aquatic, the two latter terrestrial pecies.



Palmella hyalina.

(*a*) Part of frond in which the granules are seen often assuming a quaternary arrangement.
(*b, c, d*) Plants of the ordinary shapes. (*e*) Plant lengthened out by growing in a rather rapid stream.

Grev. Crypt Fl. plate ccxliii. &c.



(*a*) Palmella protuberans. (*b*) Mass, natural size, beginning to become shapeless. (*i*) A section.
(*k*) Granules magnified. (*c*) Palmella botryoides. (*d*) A group of plants magnified. (*e, f*) Plants separated. (*g*) A section of the thallus. (*h*) Granules.

(125.) These fallen-stars and water-slime plants, though gene-ally containing threads or cells, are often found without any per-:eptible filaments or vesicles within them. In this apparently .morphous state, these vegetable slimes have been by some con-idered as " a provisional creation waiting to be organized ;" or as ı chaotic mass, whence forms the most regular and beautiful should pring.

(126.) With more probability, however, these gelatinous pro-luctions may be esteemed, as already hinted, the rudimental states of the cells and threads which, under favorable circumstances, are ubsequently developed within them : or they may consist both of he embryos and exuviæ of vesicles and filaments, which in such arly stages are individually so minute, that their separate out-ines are invisible ; and many of which remaining abortive, or be-oming but partially developed, constitute the sliny masses; while others, being fully evolved, form the simple vesicular and fila-nentous plants alluded to.

(127.) This slime, in which the vesicles are situated, and which is often more evident than the vesicles themselves, has received the name of *thallus*, from *thallo* (θαλλω), to germinate or sprout; as in it the filaments and vesicles are often formed, and from it they usually spring.

(128.) This slime-like matter, when permanently destitute of visible threads and cells, even if an abortive phycomater, cannot be proved to be the nidus of any especial flag. Hence, for convenience, it has been generally considered as an example of the lowest grade of vegetable organization, and treated of as a plant distinct from those of which it is probably only the abortive, incipient, or exuvial state. If such a view, which in the present state of knowledge it is expedient to take, should hereafter prove to be correct, this slime-like matter will rightly claim to be ranked as one of the most simple vegetables in existence. Until this obscurity is removed, or its connexions traced to any acknowledged species, it may be called (Protoglia ambigua) the doubtful slime-plant: a name proposed as being in consonance with *Proto*-spheriæ, and Proto-nemata, already given to the filaments and vesicles, which, with these jelly-like productions, may be esteemed the primitiæ of the vegetable world.

(129.) When these slimy films divide, or when the cells which they contain [see § 28, 139, &c.] are separated, each part becomes an entire, distinct, and independent plant; which grows, and again divides. The dismembered joints are called offsets, (*frustula* or gonidia,) being as it were slips or colonizing fragments, given off from the slimy mass, or parent cell, and serving to propagate the species.

(130.) The frustules or cellules of these plants, or the separated cells, which constitute entire and independent vegetables, contain small grains of various colours floating in the fluid, which distends their coats: collectively, this matter is denominated *Endochrome*,* and each grain is termed a *granule*.

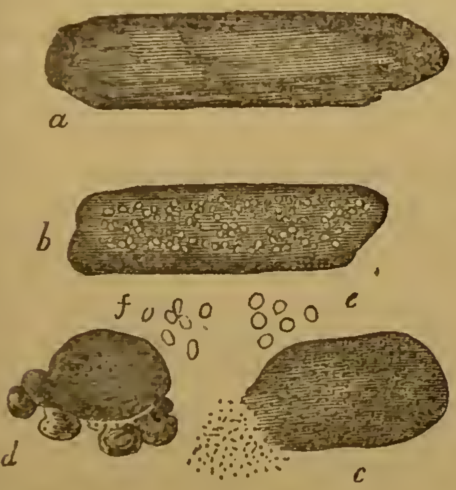
(131.) When the vesicles contain still smaller vesicles within them, the internal cells are denominated *spores*, from speiro (σπείρω), to sow, as from them fresh plants arise; and the larger cells, in which they are contained, are called *sporidia*, or spore cells: the spores in these humble tribes being equivalent to buds,

* From Ἔνδον, *Endon*, inner or internal, and χρῶμα, *chroma*, colour.

or seeds, and the sporidia to seed-vessels; although, from the simplicity of their structure, they have received another name.

(132.) Turpin, who examined many of these plants minutely, named them *globulines*, from their generally rounded forms. They are some of the simplest of the series called *Lepra*, by the older writers; and allied to the *Proto-coccus* and *Palmella* of modern systems: one species of which is familiarly known as *gory dew*, (Palmella cruenta) [vide § 44, 133], and another as *red snow*, (Protococcus nivalis) [vide § 47].

(133.) These several instances will serve to shew the varied manner of their growth and increase; for the Protococcus consists of numerous coloured vesicles or sporidia, seated on a slimy thallus, [vide § 47,] while in the Palmella cruenta, the thallus encloses the



Palmella cruenta. *Grev.* 205.

(*a, b*) Plants, natural size and magnified.

(*c*) Fertile portion of the thallus.

(*d*) Portion of the jelly-like thallus.

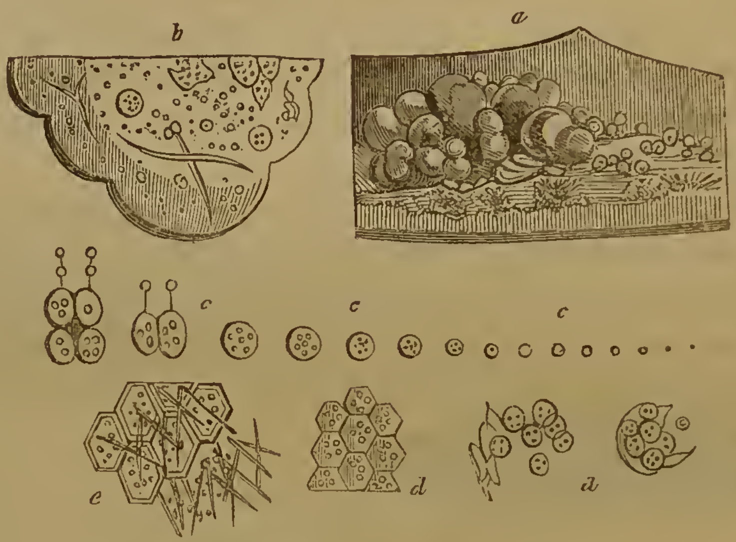
(*e, f*) Granules magnified.

globules, and in Protosphæria the cellules are free, and the thallus latent or obscure [vide § 123.]

(133.) Within the first-formed vesicles of the snow plants, as they increase in size, other still smaller vesicles are seen to form, by the growth of which they become so far distended, that the maternal films are ruptured, and a numerous progeny poured forth, in every one of which, at, or even before, the time of birth, the embryos of future generations may be seen. These, in succession, become similarly developed, and speedily run through their several stages of existence: so that, although small plants, they increase with most astonishing rapidity.

(134.) In the Globuliniæ, [vide § 28,] the mode of propagation is the same: but in them the phycomater is evanescent, or the thallus not evolved; and in a beautiful ally, named, in honour of

the celebrated Bichat, the *Bichatia*, and, from its vesiculine structure, *vesiculinosa*, the slimy thallus is in like manner abortive, so that each vesicle, immediately on its exit from the parent cell, is esteemed an entire and perfect plant; while in the Protococcus,



Bichatia vesiculinosa (natural size.)

(*a*) Masses on glass, in several states of growth and decay.
(*b*) A drop of water, on the field of a microscope, containing Bichatia and Protonema.
(*c*) Progressive increase in the size of the vesicles, union, &c.
(*d*) Parent vesicles, bursting and discharging the offspring.
(*d*) Hexagonal form assumed on compression.
(*e*) Figure of cellular texture of Mesembryanthemum barbatum, to shew similitude of cells and raphides.

or red snow, the thallus being more fully developed, and maintaining for a time a connexion between the several cells, each mass, like a tree, is considered as but a single though compound individual plant; the slimy thallus or receptacle being the bond of union, the basis of the social compact, each larger vesicle a *sporidium*, and each smaller cell a *sporule*.

(135.) The presence or absence of the slimy thallus is the chief distinctive character between the two first groups or sections of the vegetable world; for, in the one it is mostly abortive or obscure, in the other notorious and abundant. Illustrations of these two groups have now been given, and so simple are they both in structure, that it is difficult to say to which precedence should be yielded; for, although the threads and cells form each more simple plants when separated than when multitudes are held in union by the slimy thallus, still the entire development of the phycomater into cells. and its absence as a thallus, would seem to indicate a greater

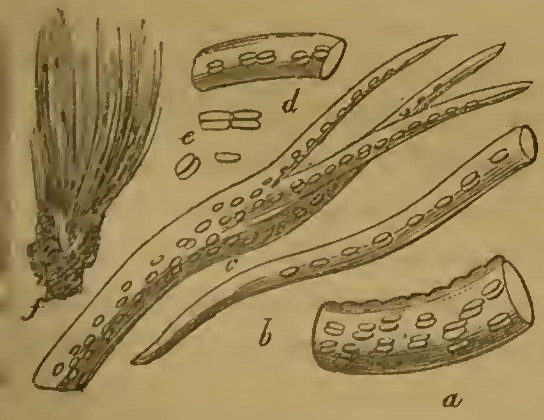
energy of life in the isolated Globulines than in their allies, Nostoc, Palmella and Protococcus, where much of it remains permanently abortive in the jelly state.

(136.) Those plants in which the thallus is absent or obscure are very fragile, and their parts easily separate from each other. Indeed, one genus has been called *Fragillaria,* from its extreme fragility, and another *Diatoma*, from the spontaneous division of its members that continually occurs. This fractional tendency is not peculiar to the two genera just named, but more or less prevails throughout the group; and hence, from *Fragillaria,* which is esteemed the normal genus, they have been collectively denominated FRAGILLINÆ, or *Fracture-worts.*

(137.) Those plants in which the thallus is predominant, or in which at least it is not very obscure, form another section, called collectively, from *Nostoc*, the botanical name of the Fallen star, the NOSTOCHINÆ, or jelly-worts. This section, as well as the foregoing, contains many curious vegetables, which, notwithstanding the labours of modern physiologists, are still much too little studied, and by far too little known. [Vide § 43, 44, 45, 46, and 47.]

(138.) A gradation may be traced from the *Nostoc,* in which the thallus is predominant, through many plants in which it becomes less and less conspicuous, to the collateral section, the *Fragillinæ,* in which it is absent, or at least comparatively obscure, and in which, when present, it separates into definite segments.

(139.) In the *Schizonema comöides* (*hair-like leather-thread*)



Schizönema comoides.

(*a, b, c, d*) Portions magnified.

(*e*) Granules.

(*f*) Tuft of plants, natural size.

Grev. Cryp. 358.

the vesicles are arranged in pairs within the slimy thallus; and in the *Schizonema quadripunctatum* (*four-celled leather-thread*), the vesicles are disposed in fours, but in (the *twinnule*) *Geminella in-*

Schizonema quadripunctatum.

(*a*) Natural size. (*b*) Filaments, separate and magnified. (*c*) Filaments, with granules. (*d*) Appearance of immature granules.

(*e*, *f*, *g*) Frustules formed by division of the thallus. (*h*) Granules, after being discharged from the tubular filamentous thallus.—*Grev.* 286.

terrupta the thallus, if present, is invisible; and its existence is only presumed from the circumstance of the cells being regularly arranged, and maintaining regular relative positions in each series; while the different series, floating about in the water, continually change their positions, in regard to each other. In the following figure, the dotted line indicates the supposed tract of the invisible thallus; the ciphers, the twin-cells of the geminella.

oo . . . oo . . . . oo . . . . oo . . . . oo

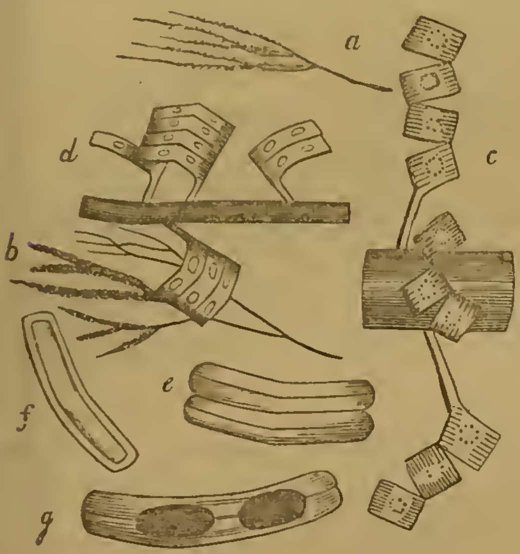
FRAGILLINÆ.

(140.) Globulinaceæ. *Protosphæria* (the spherulet), and *Protonema* (the threadlet), already described and figured, (vide § 123,) with *Globulinia* (vide § 28), form a subordinate group amongst the Fragillinæ, known by the constant separation of their cells, each of which, from an early state, forms a distinct and independent plant. In this type, which, from the normal genus *Globulinia*, is called Globulinaceæ, the phycomater is evanescent; and hence, the several cellules, having no common bond of union, separate at once into fragments, each of which is a distinct and independent plant. In Bichatia, the phycomater partially remains, and, by uniting for a time two or more cellules, shews the connexion between this and the following type.

(141.) The Globulines and their allies, Protosphæria, Protonema, &c., occur in various fluids, as in wine, beer, and many vegetable infusions. Of the two latter genera only a single species has been described, called, in either case, *simplex*. Of the genus Globulinia there are many species known, which, though nearly identical in

form, vary in their colours and their stations. Hence they have been named, either from their hues or habitats, *G. lactea*, *atra*, *sulphurea*, *cærulea*, *rubra*, *botryoides*, *vini*, *cerevisiæ*, &c.

(142.) DIATOMACEÆ, or *Fragillaceæ*. In the sea-froth plants (Achnanthes), and the different species of sea-cut thread (Schizo-



(*a*) Achnanthes unipunctata.

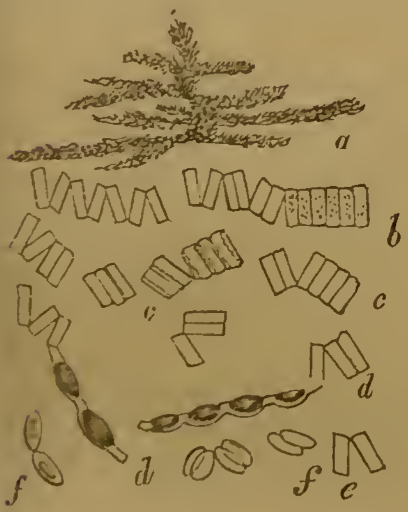
(*b*) A. brevipes, natural size.

(*c*) Portion of *a*, magnified.

(*d*) Portion of *b*, magnified.

(*e, f, g*) Joints, or frustula, separated.—*Grev.* 287 and 295.)

nema), the sea cleft-foam and fract-foam (Diatoma and Fragillaria),



Diatoma tenue.—*Grev.* 354.

(*a*) Natural size.

(*b, c*) Portions magnified, shewing their separation into frustules.

(*d*) Frustules of different forms.

(*e, f*) Frustules separated.

with their numerous allies, the thallus, though not wholly absent, is in general obscure, and hence, although the cells are for a time connected, they subsequently separate into fragments (Frustula), each portion becoming an independent plant, or the germ of an infant colony; which, as it increases in size, again divides, and multiplies by every division.

(143.) Tenacious of vitality as each *gonidium*, or frustulum, in each propagating section seems to be, yet so feeble are the powers of life with which these lower vegetables are endowed, that they

appear unable wholly to withstand the laws that govern lifeless matter, or to protect the materials they contain from common chemical affections: for, within each vesicle of several species, there are found one or more distinct and perfect crystals; probably derived from the salts dissolved in the fluids which the organic structures of the plants had enabled them to concentrate as well as to absorb. (Vide § 142.)

(144.) Until lately the genera included in the type *Diatomaceæ* formed but a single group, but, from the form of their frustula, Dr. Greville has arranged them in four subordinate associations or subtypes.

The first subtype *Cymbellidæ* (or Cymbelleæ) includes all those Diatomaceæ in which the frustules are elliptical; such as *Cymbella* (the boatlet), *Schizonema* (the cut-thread), and *Berkeleya*, a curious and very fragile flag, which has been named in honour of the Rev. Miles Berkley, a learned Algologist, who is now publishing his Gleanings of the British Algæ.

(145.) In the second subtype, *Styllaridæ* (or Styllariæ), which includes the normal genus *Styllaria*, and its allies, the frustules are flat and wedge-shaped.*

(146.) While in the third, *Fragillaridæ* (or Fragillarieæ†), they are plane, rectilinear, and often filamentous. *Fragillaria*, *Achnanthes*, *Diatoma*, and *Frustula*, are examples of this subtype.

(147.) Allied to the foregoing are certain plants in which the filaments are round or angular, not plane, and which have hence been formed into the subtype called, from *Desmidium*, the bond-weed, *Desmididæ* (or Desmidieæ).

(148.) Such are the subordinate groups into which Greville has distributed the type *Diatomaceæ*, or *Fragillaceæ*, and, as they are more definite and satisfactory than those of Fries, they are adopted here.‡

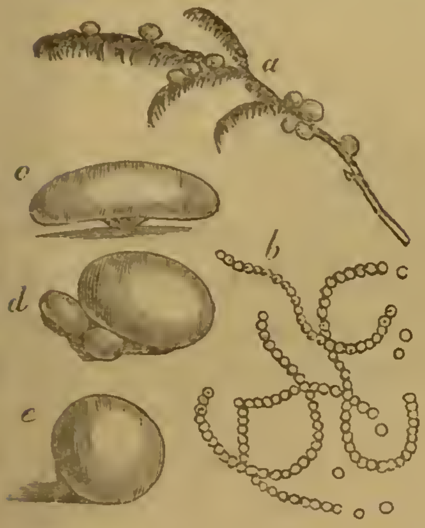
* The Styllariæ form part of Bory St. Vincent's Zoocarpes, [§ 29.]

† I could very much wish that words, like *Styllarieæ*, *Fragillarieæ*, &c., which it is utterly impossible to pronounce distinctly without putting a semicolon between each ultimate, penultimate, and antepenultimate syllable; *e.g. Styllari; e; æ*, *Fragillari; e; æ*, &c. &c., were no longer tolerated by botanists as the names of groups of plants. The above, I know, are formed according to established principle, but they are not the more euphonious on that account; and I trust that Dr. Greville will pardon me for venturing to offer *Styllaridæ*, *Fragillaridæ*, &c., as substitutes or synonymes.

‡ While these pages have been passing through the press, the first part of Dr.

NOSTOCHINÆ.

(149.) NOSTOCHACEÆ. *Nostoc*, (the fallen-star), Palmella (the



Nostoc cæruleum.

(*a*) Plant, natural size, on Hypnum aduncum.

(*b*) Filaments of cellules disarticulating.

(*c*, *d*, *e*) Plants separated, to shew their various forms.—*Grev. Crypt. Flor.* 131.

earth-dew, (vide § 124 and 132), and Protococcus (the red-snow, vide § 47), all of which have been described, form, with Hæmatococcus, and other allies, the type *Nostochaceæ*. Lightfoot states that one species of Palmella, the montana, is the *Mountain Dulse* of the Scotch: the Highlanders, he says, wash it and rub it between their hands in water, so as to make a paste, with which they purge their calves.

(150.) The *Hæmatococcus sanguineus*, or blood-stain, like the *Palmella cruenta*, or gory dew, gives to the rocks on which it grows the appearance of being stained with blood. Captain Carmichael found it "spreading over the roof of a dry cavern in a quartz rock, (Appin,) to the extent of several yards, in the form of a thick uneven efflorescence of a brick-red colour externally, but whitish within."

(151.) *Echinella*, the *hedgehog-wort*, so named from the bristly aspect it assumes, its corpuscules radiating like "quills upon the fretful porcupine," is a very curious plant, its species having (according to Captain Carmichael), the power of moving from place to place. This distinguished naturalist observes, that "these are animals, instead of plants, if the faculty of locomotion will entitle them to that rank." (*MS. quoted in Hooker's English Flora*, vol. v p. 398.)

Hooker's fifth volume of the "English Flora" has been published, and, as it contains the results of much labour in the departments here being described, I gladly avail myself of the opportunity which correcting the proofs affords of adding to the value of these Outlines, by inserting, as above, occasional extracts.

(152.) *Nostoc* being the best known genus, this type has been from it called the *Nostochaceæ;* of which the following differential characters are given by Greville: *thallus more or less globose, gelatinous or fleshy, including cellules that are either irregularly dispersed, or arranged in moniliform series.*

(153.) Rivulariaceæ. *Rivularia,* the rivulet-moss, so called because the species first known inhabited fresh water, (some of those since discovered are, however, marine,) and *Batrachospermum,* the *frog-spawn-wort,* (the appearance of which is well suggested by its name,) are the normal genera of two subtypes, the Rivularidæ and Batrachospermidæ, which, together, form the type now under consideration.

(154.) The *Rivulariaceæ* are gelatinous or fleshy plants, globose or filiform. In the *Rivularidæ* the thallus is always more or less globose, and the filaments continuous and annulated within. In the *Batrachospermidæ* the plants are often filiform, and the filaments articulated and branched.

(155.) Collectively, the two types *Nostochaceæ* and *Rivulariaceæ* form the section *Nostochinæ.* Their definite, persistent, jelly-like thallus, not separating into fragments, but rupturing and discharging its contents, appears to be the most certain diagnostic sign associating these two types, and distinguishing them from the sections by which they are followed and preceded.

(156.) Insignificant as these protophytes may appear, they will be found, on examination, to perform several very important functions in the general economy of nature. Consisting as they do, almost entirely, of slime, or a slime-like jelly, they afford a large supply of most nutritious food for the minute animalculæ that abound in the same situations with themselves; which, in their turn, become the sustenance of higher tribes; and these, again, together with several species of Conferva, are fed upon by fish.

Furthermore, these plants are most serviceable in purifying water, by associating and assimilating for their own support much of that foul matter with which all ponds and streams are continually becoming polluted, and which is so deleterious to animal life. Their uses as food and as refiners are, however, far less important than their function of elaborating oxygen, which the experiments of Priestley and his followers shew that the Confervales do, in a very remarkable degree; thus rendering the water respirable by fish and other gill-breathing animals, whose constant consumption of

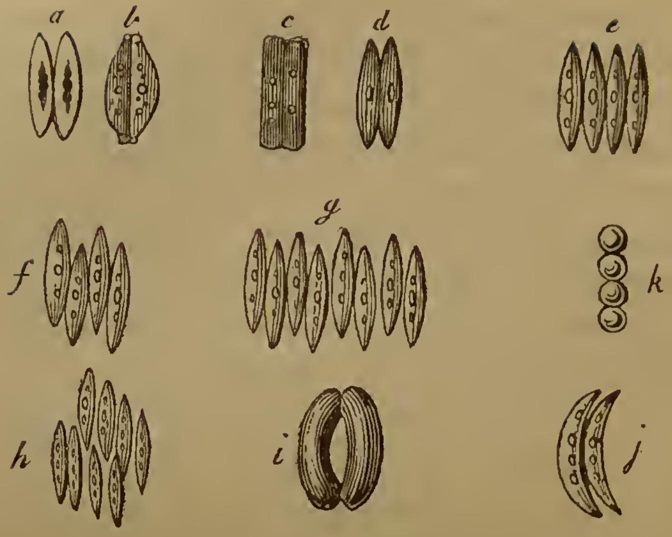
its air requires as constant a renovation. It is indeed a notorious fact, that fish are never so healthy in reservoirs destitute of aquatic plants, as in ponds and streams wherein they abound. This, in part, is owing to the oxygen which all these flags set free: but the jelly-worts have another use; for it is by their viscidity that the water is enabled to include and retain very considerable proportions of common atmospheric air; much larger quantities than it could, were it perfectly pure, and destitute of these living jellies. The air thus imprisoned, like the air contained in gelatinous beverages, such as many wines and beers, is far more abundant than persons in general suppose: its presence, however, becomes at once evident when rarefied by the sunbeams, and it is always demonstrable by artificial heat, or by means of a pneumatic apparatus.

(157.) But, interesting as the perusal of every page in the book of Nature is, the minute examination of these simple plants should not be regarded as a study affecting *their* history alone; for, as parts similar to these primitive formations occur combined in the compound textures of more elaborate vegetables, much light is occasionally thrown on the construction of the higher, by an exact knowledge of the structure of the lower grades.

(158.) Hence, as the one appears chiefly to consist of permuted repetitions of the forms of the other, the lower may, in some measure, be esteemed the uncombined anatomical elements of the higher ones offered to examination in a distinct and isolated state.

(159.) The forms of the vesicles of which these cellular plants consist have been already shewn to be very various, almost as diverse as are the forms of the cellules in the cellular textures of the most elaborate vegetables known. In the *Diatomaceæ*, the variety is greater than in either the preceding or succeeding types; for among them are found not only lengthened threads, with spheres and spheroids, elliptic, cuneate, and ovate frustules, but likewise rhombs and rhomboids, plane, and cubic, with parallelograms, &c., in almost every imaginable diversity. For example, take Tessarthonia, and Anthachne, Bacillaria, Navicula, &c., in the following figures, as well as Achnanthes, Diatoma, Schizonema, and others, previously given as illustrations. [§ 160.]

(160.) Many of these plants, it is seen, consist, in every joint, of similar and simple saccules, as in Tessarthonia and Achnanthes, of Turpin, not Achnanthes of Greville, and hence it had better



(*a*) Navicula conjugata, Turp. (Vibrio Mull.) (*b*) N. geminata. (*c*) Bacillaria conjugata, (Anim-vegetaux of Turpin; Zoocarpes of Bory St. Vincent.) (*d*) Achnanthes bijuga. (*e*) A. quadrijuga. (*f*) A. quadrialterna. (*g*) A. octallerna. (*h*) A. obliqua. (*i*) A. stomatomorpha. (*j*) A. bilunulata. (*k*) Tessarthonia moniliforme.

be called *Anthachne;*) while others, and sometimes even different species of the same genus, have appendages attached, as in Anthachne bicaudata, quadricaudata, &c., which almost resemble a chain of Q℧Q℧Q℧Q℧, alternately inverted.

(161.) In the *sea-froth-plant* (*Achnanthes* of Greville), the flattened joints are supported on processes which seem to be formed by one or more cells extended lengthwise, while the breadth is undeveloped, (§ 142.) In one species, these processes are of considerable length, while in another they remain but short; which characters distinguish the *long-legged* from the *short-legged* sea-froth-plants, (*Achnanthes longipes* from *Achnanthes brevipes.*) In the Anthachne, the *sea-froth-flower*, the appendages, when present, do not serve as points of attachment for the plants, and hence they have more the appearance of tails; and from this their specific names, *two-tailed* and *four-tailed*, have been derived.

(162.) In other plants this change of form, from the spheroidal to the linear, may be traced through almost every gradation. From the *Tessarthonia* [§ 160, *k*], and *Anthachne* [§ 160, *d*, *e*, *f*, *g*, *h*, *i*, *j*], through the *Bacillaria* [§ 160, *c*], the *Navicula* [§ 160, *a*, *b*], &c., to the simple threads of the Protonemata of Turpin; (not the Protonemata of other authors, which are much more complex plants,) [vide § 123.]

(163.) Instances in which these filamentary productions are intermingled with undegenerate cells of the ordinary shapes, serving to connect them with each other, are found in the allied section, the *Nostochinæ*, especially in those plants which have hence been named *Chætophora*, the bristle-bearer, *Corynephora*, the club-bearer, *Myrionema*, the many-thread, and others. And observations would seem to favor the belief, that this admixture of cells and threads in the gelatinous thalli of many *Nostochaceæ*, depends upon the varied predominance of two opposite modes of development; and that, while some cellules retain their spheroidal or sub-spheroidal forms, others are developed longitudinally, or, as it were, wholly in appendages, the intermediate cavity degenerating, or becoming at length entirely obliterated, and then constituting a fibre.

(164.) Hence these simple plants shew the influence of the two powers or principles which regulate the varied forms of vegetable growth. For, the cellules which are globular in Protococcus [§ 47], Globulinia [§ 28], Protospheria [§ 123], and Bichatia [§ 134], may be considered as extended into lines in Protonema [§ 123], or flattened into disks in Diatoma; extremes where, on the one hand, little but axis, and on the other, little but circumference, remains; and towards which the lengthened ellipses of Anthachne [§ 159], and the oblate spheroids of Heterocarpella, are on either side approximations.

(165.) The vesicles thus consituting these simple plants are associated in very various numbers. Often the cells collected or united are so numerous as to defy computation; but in many they are definite, and in these there is a remarkable tendency apparent to the junction of the cells in pairs, or in some multiple of two. Take, for example, the *Anthachne* bijuga, quadrijuga, quadrialterna, octalterna, &c. [§ 159], as well as the *Tessarthonia* [§ 159, *k*], the *Navicula*, conjugata, and decimata [§ 159, *a*, *b*], the *Bacillaria* [§ 159, *c*], and others already referred to; as well as many more, which might be given in illustration, would not these suffice.

(166.) Thus the theory of definite proportions, so important to the chemist, is found not to be confined to the productions of the inorganic world; it is a doctrine which teaches much to the student of nature in every department, who hence will learn that nothing has been made, without a due regard to number, weight, and measure.

(167.) These plants afford the earliest instances in which this numerical progression can be shewn; and although various exceptions may occur, subsequent examples will prove, much more fully than these can do, the extent and value of the law. Two is the element among these simple plants; but other numbers, especially three and five, will form elements in other series.

(168.) These lower vegetables, which consist of slime alone, or of threads and cells containing sometimes smaller cellules, occasionally connected by films of slime-like matter, are often the dwellings and the food of many of the minute animalculæ to which a spontaneous birth has been most gratuitously imputed; which have been supposed to spring unbidden into life, and by some to be changed into animals from plants.

(169.) Extraordinary details of these apparent changes are on record. One naturalist declares that he has seen animals take root; and another, that plants, and even minute parts of plants, or small fragments of vegetable structure, as of the grains of wheat or barley, or the berries of yew, when separated and diffused through water, reassume each an independent animality, which had only been suspended whilst they formed parts of larger plants: and that, after having for a time enjoyed their animal existence, they become associated into lines which constitute *confervæ*, or attach themselves to the roots, or other parts of growing vegetables; whose growth indeed depends, according to this theory, upon the attachment of such monads in myriads to the extremities of their roots and other parts.

(170.) The phenomena which have seemed to favor this belief are, first, the appearance of animalculæ in vegetable infusions; and secondly, the motions which the particles of organic bodies are seen to perform after their dissolution, or separation from each other: which latter circumstance has led some very able naturalists to assert, that all the larger animals and plants are built up of smaller ones, called monads; and that the decease of a man or a tree, is not so much a death, as a dissolution; for that, when the bonds which held myriads of monads together to form a single individual are loosened or dissolved, that then they all again resume their independent vitality, the destruction of one giving freedom to many.

(171.) But locomotion, by which the animality of certain minute corpuscules was once presumed to be established, has

lately been proved to be no evidence of vitality at all. Dutrochet has demonstrated that locomotion may, and often does, depend upon external physical causes, and not upon any individual volition. He observed, that fragments of moss will move about, as if spontaneously, in the water in which they float, [vide § 36;] and subsequent experiments have shewn that bags of bladder, or other permeable membrane, for a limited period, under certain circumstances, do the same. And furthermore, Dr. Brown has discovered the extraordinary fact, that the smallest fragments into which matter, whether organic or inorganic, can be divided, are all, when suspended in a fluid, constantly in motion, [vide § 38.]

(172.) With regard to the apparently fortuitous generation of animalculæ, and their supposed transformations into plants, it should be observed that, from the minuteness of the objects to be examined, from many floating about in water unattached to any soil, and from the extreme simplicity of their structure, it is often very difficult, and sometimes impossible, to determine with precision what are the vesicular ova of certain animals, and what the vesicular sporules of certain plants; and even to distinguish the simpler animalculæ and microscopic vegetables from each other. This is owing partly to the similarity in the forms of some; but more to the ova of the former being deposited and hatched in the vesicles or amongst the slime of the latter, a condition by which the whole mass becomes replete with animal life, and the slimy thallus enlarged at the expense of the cellules, that often, in such cases, remain abortive: just as, in the formation of galls by the puncture of insects, a tumor is produced by the excessive development of the pulpy structure, which involves the abortion of the parts that would have been otherwise naturally produced.

(173.) These are the phenomena which have probably countenanced the theory of the metamorphosis of plants into animals, and of animals into plants; a change, of which it is believed there has been hitherto no positive evidence adduced. That there are beings which, during a part of their existence may be attached and germinate, and subsequently become detached and swim about from place to place, has already been shewn with respect to the zoocarpes, and other examples will be adduced hereafter. Yet such changes are only the common laws of their existence, just as the metamorphoses of insects are of theirs. But the idea that an

animal, even the favorite *monas termo*, can be produced by the dissolution of the simple vesicular structure of a plant, is a position not only without proof, but no longer tenable as an hypothesis, since Ehrenberg has shewn the elaborate organization which exists even in these microcosms, [vide § 27.]

CONFERVINÆ.

(174.) In the two preceding sections of this order, the Nostochinæ and Fragillinæ, the thallus is very variably produced. In the one, although definite, it is often little else than an amorphous mass of slime, in which numerous threads and cellules are contained; and in the other it is so obscure, or so far abortive, that the cells readily break away in fragments from each other. In this third, or succeeding series, it assumes another form; for the slimy matter from which, in *Schizonema* [§ 139], the cellules are discharged, and the existence of which in Geminella [§ 139] is wholly hypothetical, becomes, in the Confervinæ, more and more membranaceous in its structure, or is replaced by a membrane in which there is no trace of organization, but which confines their vesicles, and determines, in many instances, their shape, as if they had been put into a mould; although, from its transparency and thinness, its presence is often overlooked.

(175.) If the contained vesicles are relatively few in number, they often remain spheroidal, as in the necklace-like frog-spawn-wort, *Batrachospermum moniliforme*; but, in the Confervinæ, the membrane investing the series becomes blended and lost to vision, by its joining with the walls of the various cells. In others, where the tubular thallus is comparatively small in its diameter, the cellules elongate, and from round become elliptic, &c., and at length the ends are flattened against each other, as illustrated in the following examples:

(A) Conferva curta, natural size. (B) A portion magnified. (C) Filaments still further magnified. (*a a, b b, c*) cells varying in shape in the same filament. (D) Conferva ærea. (E, F) Portions of filament magnified, to shew the variations in the form of the cells *a, b, c,* and *a, b, c, d, c, f*. (G) Conferva rivularis. (H) Threads magnified.

(176.) The vesicles thus connected, and more or less condensed, according to their number and the tubular diameter of the thallus, form at their various junctions apparent joints, which have been called *articulations;* but these articulations of the cells being invested by a continuous external membrane, are very different from the easily separable articulations of the Diatomaceæ, which are rather disarticulations than truly joints; and hence, although some of these Confervaceæ, as the water-net, Hydrodictyon, do occasionally propagate by the disintegration of their members, it is by no means common for this series of plants to separate into fragments spontaneously: they more frequently propagate by a rupture of the cells, discharging the sporuliferous endochrome, which the respective joints contain.

(177.) Oscillaceæ. The Quick Mosses, or *Quiver-worts*, so called from the vibratory movements or oscillations of their gelatinous fronds, whence indeed is derived their technical synonyme *Oscillaceæ*, form the first type of the section Confervinæ. There are some of them aerial and some aquatic plants; they abound in damp shady situations, in the sea, in ponds, ditches, streams, and even in thermal springs, such as those of Bath, and are of much use in fixing loose sand, and aiding in the deposition of mud. They

are as it were the strainers and refiners of nature; for, sometimes rising and floating on the surface, and then sinking through the water to the bottom, they involve, in their filamentous and gelatinous structures, much of the floating refuse matter which they and their allies have been unable to digest as food. Their action may be likened to that of mucilage or isinglass, put by brewers in their vats to refine the beer. And it is by these, and similar plants, that a great deal of mud is not only precipitated from water, but restrained at the bottom of streams, so that rivulets run with crystal clearness over successive strata of offal, which are thus curiously kept undisturbed.

(178.) *Oscillatoria*, *Lyngbya*, *Rosaria*, *Calothrix*, and some other Confervinæ, found either "in fresh water, the sea, or on damp ground, have been associated to form the type Oscillaceæ, of which the first named is the normal genus. According to Mr. Hervey, whose definition is the most satisfactory yet published, they are chiefly characterized by having their "thalli green or brown, rarely purple, continuous, tubular, seldom branched, though often agglutinated together so as to appear branched; fructification, an internal mass divided by transverse septa, finally separating into roundish or lenticular sporidia."—*Hooker.*

(179.) Perhaps the most familiar example of this group is the *Lyngbya muralis*, and, from its being the most common, it is, probably, likewise the most important. This plant, says Smith, forms in the wet months of winter a verdant tapestry on damp walls and stones, in confined areas and dark subterranean buildings, in which the inhabitants of crowded cities gasp for air, the effects of which on the atmosphere, by rendering it something more respirable, must be as beneficial as those observed by Priestley, to be produced by analogous species on corrupted water.—*Eng. Flor.*

(180.) The natural history of the oscillatoriæ is too interesting to be passed wholly without notice. They are so rapid in their growth and increase, that, as Captain Carmichael says, if from a stratum which on moist ground may occur of indefinite extent three feet and upwards across, a small portion be taken not more than a line in diameter and placed on a watch glass filled with water, the whole area of the glass will be overspread with filaments in the course of the night.

(181.) From the unpublished MSS. of this accomplished naturalist, Mr. Harvey makes the following extract, which is so

curious that I prefer transcribing it complete, to offering any abridgment.

"I have been induced to bestow considerable attention on such of the species as fell under my notice, on account of the singular motion remarked in the filaments by various naturalists; and I do confess, that the result is something like conviction that they belong rather to the animal than to the vegetable kingdom. This motion or oscillation has been attributed to various causes,—to the rapidity of growth, to the action of light, or to the agitation of the water in which the specimens were immersed for inspection; but none of these affords a satisfactory explanation: the last may be put to the proof by a very simple contrivance. Let a small portion of the stratum be placed in a watch-glass nearly filled with water, and covered with a circular film of talc, so that its edge may touch the glass; the water will be rendered as fixed as if it was a piece of ice. The glass may now be placed under the microscope, and the oscillation of the filaments viewed without any risk of disturbance from the agitation of the water. By following this course, it will be speedily perceived that the motion in question is entirely independent of that cause.

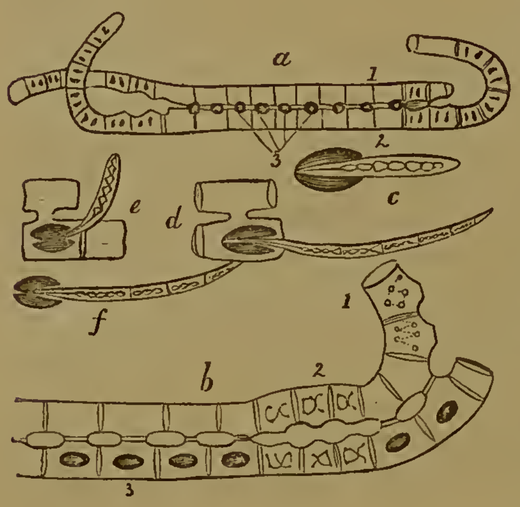
"The action of light, as a cause of motion, cannot be directly disproved, because we cannot view our specimens in the dark; but indirectly there is nothing easier. If a watch-glass, charged as above, be laid aside for a night, it will be found that, by the next morning, not only a considerable radiation has taken place, but that multitudes of the filaments have entirely escaped from the stratum, both indicating motion independent of light. Rapidity of growth will shew itself in a prolongation of the filaments, but will not account for this oscillation to the right and left; and still less for their travelling, in the course of a few hours, to the distance of ten times their own length from the stratum. This last is a kind of motion, I believe, unexampled in the vegetable kingdom. There is another point in the history of the Oscillatoriæ which favors the opinion that they are animalculæ; it is the extremely limited term of their existence. The community (if I may so call it) lives for several months, but the individuals die off, and are succeeded by others with a rapidity [vide § 180,] to which there is no parallel among genuine plants."—*Algæ Appinenses.*

These facts are most curious, but they do not appear fully to warrant the conclusion the learned writer seems inclined to deduce of the animal nature of the Oscillatoriæ. These beings, which are "on the isthmus of a middle state," are certainly as much plants as the Echinellæ, already mentioned [151], and as the Vaucheria clavata, shortly to be described.

(182.) Confervaceæ. The *Zygnemata*, or yoke-threads, form the connecting link between the Oscillaceæ and the present type; and their history is not less remarkable than that of the Oscillatoriæ, just described; for these plants, which are hair-like filaments, float side by side, or cross each other at intervals, and then unite, in a most extraordinary manner, by shooting forth processes which grow to-

gether, and form channels, through which the grains of endochrome contained in the cells of the one can flow into the corresponding cellules of the other. Subsequently to this natural grafting, the filaments separate again, and the sporules which have been formed either in the intermediate channels or in the original cells, are dropped into the water, and, germinating, give rise to a fresh generation.

Vaucher included among his Conjugatæ numerous species, which have since been distributed into several genera; one being the Zygnema just described. The accompanying figure is the *Conjugata pectinata* of Vaucher, and the *Zygnema pectinatum* of Agardh; but a further analysis having been made by Bory St. Vincent, it is now called *Tyndaridea,* from Tyndaridæ, the common name of Castor and Pollux.

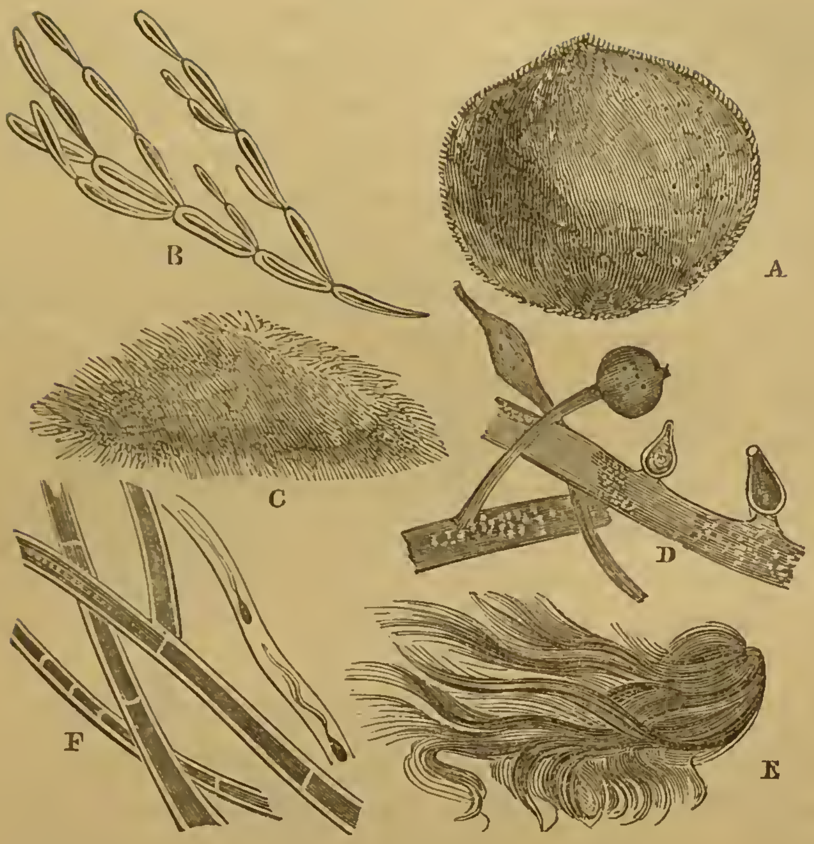


Tyndaridea pectinata (Zygnema pectinatum.)
(*a*) Two individual plants becoming engrafted naturally together.
1, 2. Pullulations from each, projecting to form the union.
3. The common spores or fruit.
(*b*) Zygnema deciminum.
1, 2. Endochrome in the form of a roman X.
3. Fruit, after the engrafting has taken place, collected as a globule in one of the filaments.*
(*c*) Spores germinating (free).
(*d, e*) Spores germinating within the cellules.
(*f*) Ditto, become free from decay of the cellule.

(183.) *Conferva,* though very much restricted since the time of Dillwyn, who included under that generic name almost all the types and sections of the present order Confervales, still remains an extensive genus, which may probably hereafter be again subdivided and further reduced. Conferva curta, ærea, and rivularis, or the dwarf, verdigris, and river crowsilks, [§ 175,] have already been figured; and C. ægagropila, vesicata, and crispata, may be taken as further illustrations of the genus.

(184.) *Conferva rivularis* [§ 175, A. B.] is very common in running streams; *C. curta* is a dwarf crowsilk, parasitic on Fuci;

* The draughtsman, in taking this figure from Vaucher, has combined the characters of two species; the endochrome in the curled end being in the form of a roman V repeated, which is distinctive of *Z. quininum.*



A. Conferva ægagropila, entire plant; natural size. B. Filaments separated, to shew their articulated cellular structure. C. Conferva vesicata; natural size. D. Filaments, with the vesicles magnified. E. Conferva crispata. F. Filaments magnified, shewing the variable length of the cells.

and *C. ærea* is also a marine species, common on the seashore: the long-tufted filaments of the latter assist in fixing the loose sand with which rocks are often covered.

(185.) *Conferva crispata*, (the curled crowsilk,) which is often thought to be only a variety of the common Conferva fracta, (broken crowsilk,) is found in vast abundance in ditches, both of salt and fresh water, forming immense strata, which, when they rise to the surface, cover the water, often for miles together, with a coat several inches in thickness. Between Bognor and Little Hampton I have seen it in the most astonishing profusion. These are some of the confervæ that contribute most to the clearing water, and filling up ponds and lakes. Economical peasants sometimes use these crowsilks as wadding for stuffing garments. They have also been woven into cloth; and Lightfoot says he has seen a kind of paper made in Edinburgh, from Conferva fracta.

(186.) *Conferva vesicata*, or the bladder-crowsilk, [§ 183, C. D.] is a curious though common species, found in stagnant water. It

is chiefly interesting from the tumid cells with which it abounds, prefiguring the conceptacles of the next type, and of the still higher Fuci. In it the endochrome is extremely evident, which, escaping in this group by an irregular rupture of the coats of the cells becomes the sporules whence fresh plants arise.

(187.) The *Conferva ægagropila*, the globe-crowsilk, or moor-ball, is a very extraordinary plant, [§ 183, A.B.] The numerous filaments of which it is composed grow closely impacted in a nearly spherical mass, so that a ball is formed, a good deal resembling those lumps of hair found occasionally in the stomachs of kids, calves, and horses. It is a wandering plant, unfixed to any soil, and entirely at the mercy of the waves. It is found in lakes, but it is rare. The only use to which it has been applied has been to wipe pens upon; for which purpose its soft porous texture fits it well.

(188.) *Hydrodictyon*, [vide Dillwyn, 97,] the water-net, which floats freely, spreading abroad its pentagonal meshes, which divide at their joints, in the same manner as the Fragillinæ, and Mougeottia, a genus separated from Zygnema, and named in honour of Mougeot, a German botanist of celebrity, might be given as further illustrations. This latter genus, and especially one species, the M. compressa, like the Hydrodictyon, shews an affinity to the lower tribes, by its fragility; and so various are the modes in which the articulations hang together, that Captain Carmichaël appears to have been inclined to consider each joint a distinct individual plant, and a filament (to repeat his own words), to be "a chain of individuals cohering somewhat in the manner of the genus Salpa among the Mollusca."

(189.) CERAMIACEÆ. In the most numerous species of this section, the granules contained in the various joints are the sporules, which, when scattered by the rupture of the walls, serve to perpetuate the plants; but, in the more highly developed series, the Ceramiaceæ, instead of the sporules being indifferently situated in all the cells, some cells develop no fertile spores, while in others they are evolved most abundantly. These fertile cells are called *thecæ*, or spore cases; and they, after a time, like the other cells, burst, and discharge their contents.

(190.) When such a separation of function takes place, the term *frond* supersedes the use of *thallus;* and the contrary extremity of the frond to that which bears the thecæ often becomes less ex-

panded, and then is called a *stipes*. The end of the stipes is sometimes, though improperly, termed *a root*, but it is only the *base* of the frond: the true root is the result of a further development of the axis in union with an organ not yet explained. The base of the rootstake, or *rhizoma*, which has hitherto remained abortive, or only imperfectly evolved, in this shield-like expansion, is called the shield or holdfast, *scutum* vel *clavulus*.

A. Ectocarpus littoralis, parasitic on a fucus; natural size.
B. Filaments magnified. C. Portion with fruit.
D. Dasya coccinea; portion natural size. E. Portion magnified.
F. Fruit, *a*, discharging sporules, *b*, magnified.
G. Ceramium rubrum, (reduced, entire plant.)
H, I. Portions magnified; one with fruit.—*Dillwyn*, 31, 34, 36.)

(191.) The examples figured are *Ectocarpus littoralis*, (A, B, C,) a very common parasite, found on the larger Algæ; *Dasya coccinea*, (D, E, F,) the scarlet hair-wort, one of the most beautiful and abundant British illustrations of the type; *Ceramium rubrum*, (G, H, I,) the red vase-weed. *Ceramium ciliatum* (§ 3, fig. 2,) is a curious spiny species, and is remarkable for its rigidity and fragility, "the filaments breaking in the hand, as Mr. Sconce observes, as if the joints searated like those of an equisetum."—*Hooker, Eng. Fl.* 336.

(192.) Ectocarpus and Ceramium have both been considered normal genera, and this type has therefore been sometimes called

Ectocarpeæ, and sometimes *Ceramieæ;* but, as two subtypes have been formed bearing those names, *Ceramiaceæ* is the collective term by which the common group is designated here.

(193.) The Ceramiaceæ are well distinguished from all the other Confervales by their external fructification; and the two subtypes, which thus far agree, differ both in the colour of their fronds and the distribution of their conceptacles: the Ectocarpidæ (or Ectocarpeæ) being green or olive-brown, and bearing two forms of fruit, external conceptacles, and globules in swollen filaments, on the same plant; while the Ceramidæ (or Ceramieæ) are either red or purple, never green, rarely brown, and their joints beautifully transparent. They also bear their twofold fructification, not on the same, but on two different plants.

(194.) All these modifications of structure, which seem scarcely essential in such humble vegetables, prefigure, in an extraordinary way, the most elaborate organs of the more highly developed plants. They often anticipate as it were not only future internal textures, but also external forms; and sometimes the likeness is so strong as to have suggested an identity in name: *e. g.* take *Griffithsia equisetifolia*, *Calithamnion thyöides*, &c., which seem, from their aspects, to be the shadows which coming events have cast before.

(195.) The three types, Oscillaceæ, Confervaceæ, and Ceramiaceæ, although differing as to their fructification being external or internal, and in other particulars detailed in the histories of the respective groups, all agree in having articulated filaments, the cellules of which are contained within a fine membranaceous tube; the gelatinous thallus having become abortive. These common characters are therefore their associating as well as their differential signs.

(196.) In tracing the gradual series of developments through the simpler Algæ, a tendency to distinction in the uses of different parts becomes progressively more and more evident. In the loose and floating twinnules, in the cleft foam in the Nostocs, and in the red-snow, every portion of the surface appears equally able to absorb nourishment for the support and growth of the individual plant; and every part seems equally fertile, and able, by gonidia or sporules, to reproduce its kind; so that these two essential systems, that of reproduction and that of nutrition, without which the individuals could not exist, neither could the species be continued, are blended into one mass, and are either indistinguishable

from each other, or, when somewhat more advanced, still have one receptacle in common; but as the receptacle, or thallus, becomes more extended, a distinction takes place: a kind of stem is produced, as seen in an elementary state, even in the Achnanthes, and still more notoriously in the vase-worts (Ceramiaceæ.) This stem, in all these plants, is called a *stipes*, and is the organ or system of extension, in part distinct, and, according to the greater or less development of which, the organs of nutrition and reproduction are more or less separated from each other. As long as both the reproductive and nutritive systems are universally spread throughout this organ of extension, it is called a *thallus;* as soon as the reproductive sporules are collected into groups, it receives the name of *frons;* the groups of sporules being called *sori*, and the parts of the frons in which they are seated, *thecæ* or *conceptacles* (conceptacula); often also *capsules*, but this latter name, as will hereafter appear, is very objectionable.

(197.) From the systems of nutrition and reproduction being thus, in many individuals, blended, their presence has often escaped the notice of inaccurate observers, and their existence has even been denied. Hence likewise has arisen the supposition that certain plants are produced by chance, *i. e.* spring out of the earth, or from the dissolution of the substances on which they are found, without the intervention of other beings like themselves; *i. e.* without parental aid.

(198.) But the reproductive, as well as the nutritive system, is essentially present in some individuals of every species, at some period of their existence; and although in a few both have not been hitherto corporeally detected, their potential presence is declared by their effects; and the more scrupulous the investigations become that are made into these obscure recesses of nature, the less reason is there to doubt the generality of the dogma, "omne vivum ex ovo."

(199.) Many of the cases in which these reproductive organs are not demonstrable are, in all probability, the young or barren states of plants, which are fertile in other individuals of the same species, or in subsequent stages of their existence: *e. g.* mosses, and many other vegetables, are so greatly affected by locality, that in one situation they are constantly and universally fertile, and in another as constantly and universally barren; while some, which had long been considered sterile plants, stricter observations have shewn to be only the infant or abortive forms of well-known fertile vegeta-

bles. Of this the well-known Byssus velutina, which is now ascertained to be only the rudimental state of Polytrichum aloïdes, affords an apposite example.

(200.) With regard to the assumed spontaneous production of the Confervales, there has been a series of very satisfactory experiments placed on record by Fee, in his "Essai sur les Cryptogames des Ecorces officinales." This botanist found that, without the access of air, the common recipient and carrier of the seminules of such plants, none ever grew in water that was known to be perfectly pure, and that the periods and proportions of their development were in an inverse ratio with the purity of the water and the exclusion of the air. In distilled water contained in vessels hermetically sealed, or in open vessels kept in closed chambers, none were ever found to grow. One hundred and three days passed before any were detected in pure water placed in open vessels, and exposed to the atmosphere. In rain-water they were nearly double the time (one hundred and forty-seven days) in making their appearance, when in open vessels kept in closed chambers, to what they were in the same water exposed to the open air, (eighty-five days.) In river-water their coming was found to be more speedy than in rain, or in the water drawn from wells. Filtration also retarded their appearance; and in water from stagnant pools they were the most rapid and abundant in their growth, requiring only nine days, which is less than an eleventh part of the time necessary for their production in pure water, even when exposed in open vessels to the influence of the air.

(201.) But persons in general have been so long accustomed to regard fruits and elaborate seeds as the only organs of specific reproduction in plants, and roots as their only organs of nutrition, that the potential presence of the root, as diffused all over the absorbent surface, is often with difficulty admitted, notwithstanding it nourishes the plant, and is an efficient nutritive system; and the potential presence of the reproductive organs has hence likewise been denied, when plants are propagated by spores alone, or by the disarticulation of the various parts, although gonidia and sporules are as efficient as seeds in the office of reproduction.

(202.) In the succeeding series of the Algæ, or flags, these organs are still more distinct and evident than in the most distinct of the preceding sections; and those three systems, which, when inseparable from each other, are denominated the *systems* of nutrition, extension, and reproduction; when separable, and chiefly

collected in especial parts or members, are then in general named the *organs* of nutrition, extension, and reproduction; the organ of extension being the part on which the nutritive and reproductive organs are seated, and to which they are attached.

(203.) All the plants which as yet have been given in illustration of the types Globulinaceæ (or scum-worts), Diatomaceæ (or cleft-reets), Nostochaceæ (or jelly-worts), Oscillaceæ (or quick-mosses), Confervaceæ (or crow-silks), and Ceramiaceæ (or vase-worts), however much they may differ as to the form, and number, and modes of union of the cells, the abundance or destitution of thallus, &c., still agree in their jointed structure, *i. e.* in the articulation of the vesicles. The series rises in several gradations, beginning with those in which each cell or joint is separated or disarticulated from all the rest; it then proceeds by those in which the vesicles, at one time connected, disarticulate spontaneously, to those in which, although the junction of the cells is evident through the transparent thallus, no spontaneous separation essentially takes place. Hence, collectively they have been named (Algæ articulatæ, or) jointed flags; (Arthrodieæ, or) joint-worts, joint-reets, &c.; and sometimes Confervæ, as formerly most of those which then were known were included in a single group, or genus, named Conferva, from the use which the ancients made of several species, as applications to confirm or strengthen the union of fractured bones. Therefore the Confervæ have a double claim to their appellation, *joint-worts;* firstly, from their former use, and, secondly, from their articulated structure.

(204.) *Confervæ* (or joint-worts), is hence perhaps the least exceptionable name that has been hitherto proposed; but, as some are characterised by disarticulations rather than by their articulations, and in others the articulations become confirmed in one continuous thread; and moreover, as the order includes the Nostocs as well as the Confervas (generally so esteemed), perhaps it would be advisable to blend the two names in one common appellation, or to call them collectively Confervales, of which our provincial *reets* may be taken as the English synonyme.

(205.) This rustic name appears, like *reeds* and *reeks*, both given, like *reets*, to plants that grow in damp places or in running waters, to be derived from the same original root, ῥέω, to flow; and, notwithstanding the two latter have long been all but obsolete, they are in some provinces still retained, the one being applied to such minute plants as are terrestrial, with which the ground is

said to reek; the other to those thread-like masses which prevail in water: and their flowing, flaccid forms are not inaptly expressed by this almost forgotten word.

(206.) The plants already described will suffice to illustrate several progressive stages of systematic or methodical arrangement; *e. g.* all those which agree in certain fixed characters form a group, and constitute what is botanically called a species, as the long-legged sea-froth-plants, the short-legged sea-froth-plants, &c.; while these two, or a similar association of any other concordant species, form a genus. In this instance, the genus Achnanthes; in another, the genus Diatoma; in another, the genus Fragillaria, and so forth; all which, agreeing in their flattened joints, easily separable into fragments, form a type, called, from the genus Diatoma, the *Diatomaceæ;* the types being always indicated by the termination *aceæ.*

(207.) Other genera form other types, as Globulinia, Protospheria, and Bichatia, the type *Globulinaceæ*, which, with the *Diatomaceæ*, forms the section Fragillinæ; the sections being known by the termination *inæ*, which is generally affixed to the name of the best known or most important genus. In like manner, Nostoc, Palmella, Protococcus, &c., form collectively the type *Nostochaceæ*, which, with the *Rivulariaceæ*, constitutes the section Nostochinæ.

The *Oscillaceæ*, *Confervaceæ*, and *Ceramiaceæ*, are other types or groups synthetically formed on similar principles, and from their association results the section Confervinæ.

(208.) The sections Fragillinæ, Nostochinæ, and Confervinæ, combine to form the order CONFERVALES; of which the following table will furnish a synopsis. Three of the types, viz. *Diatomaceæ* [vide § 144 to 148], *Rivulariaceæ* [vide § 153], and *Ceramiaceæ* [vide § 193], admit subordinate groups of genera, called subtypes, which stage of synthesis is marked by the termination *-idæ* or *-eæ;* but, as these are not common to all the types, and are scarcely essential even when found, they are not admitted into the tabular conspectus.

Order.	Sections.	Types.
Confervales	Confervinæ	Ceramiaceæ.
		Confervaceæ.
		Oscillaceæ.
	Nostochinæ	Rivulariaceæ.
		Nostochaceæ.
	Fragillinæ	Diatomaceæ.
		Globulinaceæ.

GEOGRAPHICAL DISTRIBUTION OF THE CONFERVALES.

(210.) From the more equable temperature of the medium in which they live, the range of aquatic, is often much less confined than that of terrestrial plants. Water so far diminishes the heat of the torrid, and moderates the cold of the frigid zones, that several pond and river weeds are known to flourish from the equator to the poles: for example, the European bulrush (Typha latifolia,) has been found in Siberia, North America, Jamaica, China, and the peninsula of Hindostan; our common duck-meat (Lemna minor), which spreads over the whole of Europe, is a native also of North America and Asia, being found in the waters of Pennsylvania and Carolina, as well as in those of Siberia, Tartary, Bucharia, China, Cochin-China, and Japan.

(211.) But, although cosmopolites occur amongst those which are usually considered much superior and more perfect plants, it is a curious fact, that there are very few of these inferior grades which seem able to endure equivalent vicissitudes of climate.

(212.) Confervæ are comparatively rare between the tropics, and, although not entirely confined to the temperate zones, they become gradually more abundant in the higher latitudes, both of the northern and southern hemispheres.

(213.) This is a circumstance deserving especial notice, and the more so, as it is one that could not have been presupposed. Speculation would have suggested that the mud of the Ganges and the Nile, the pools and tanks of Egypt and of India, which swarm with animal life, would not have been less prolific nests of the still simpler forms of plants. But the contrary appears to be the truth; for, whatever allowance may be asked for the less accurate researches that have been made in this department of natural history in extra-European countries than in our own, still the broad fact is sufficiently established: so that of their comparative paucity in warm countries there can be no doubt.

(214.) Connected with the subject of the general geographical distribution of the Confervales, there is a circumstance worthy of remark, not only on its own account, but as indirectly corroborating the statements already made, which, though founded on good evidence, would have been more satisfactory had the examinations been more minute. The hint was first thrown out by Brongniart, that no true Confervæ are found in warm springs. This remark has been since confirmed, and I do not know that it admits of any exception; for those Confervales which have been mentioned as

inhabiting the Bath and similar thermal waters, belong to the type Oscillaceæ; a group which, it will be remembered, [vide § 181,] verge towards the animal kingdom, and which some naturalists of authority have even wished to exclude from the vegetable reign.

(215.) Hence it will appear that the chief geographical range of the Confervinæ, and especially of the types Confervaceæ and Ceramiaceæ, is in the temperate zones; the Confervaceæ abounding both in salt and fresh water; the Ceramiaceæ being exclusively marine.

As the Oscillaceæ occur in hot springs, along with some of the Ulvaceæ [vide § 241, &c.] that inhabit tropical seas, it is very probable that they will be found, on further examination, to approach nearer to the equator than their allies; but of this no direct evidence has been adduced.

(216.) The range of the Nostochinæ appears to be much more extended than that of the Confervinæ; for Palmella, Nostoc, and their allies, are common plants in most temperate regions; while Protococcus abounds not only on the Frozen Mountains, near the North Pole, but is likewise a native of the British Isles, is met with in profusion in the Alpine districts of France, Spain, Switzerland, and Italy, and perhaps even at Paramo, in South America, nearly under the Line [§ 45.]

(217.) Whether this plant be indigenous to all these various latitudes, or only a visiter to some, is at present undetermined; but, as it is most permanent and abundant towards the north, and on mountains having a northern altitude, it is likely that its appearance in more southern regions, and in warmer climates, may be owing to occasional migrations.

(218.) Of the geographical distribution of the Fragillinæ, far too little as yet is known to allow any generalizations to be ventured; but as many of them are either parasites or epiphytes, and others, as the Globulinaceæ, are for the most part peculiar to certain fluids or solutions, it is probable that their distribution will partake more of a local than a general character; and that they will be found to be more affected by accidental circumstances, always varying, than by the physical constitution of a country, or the vicissitudes of climate.

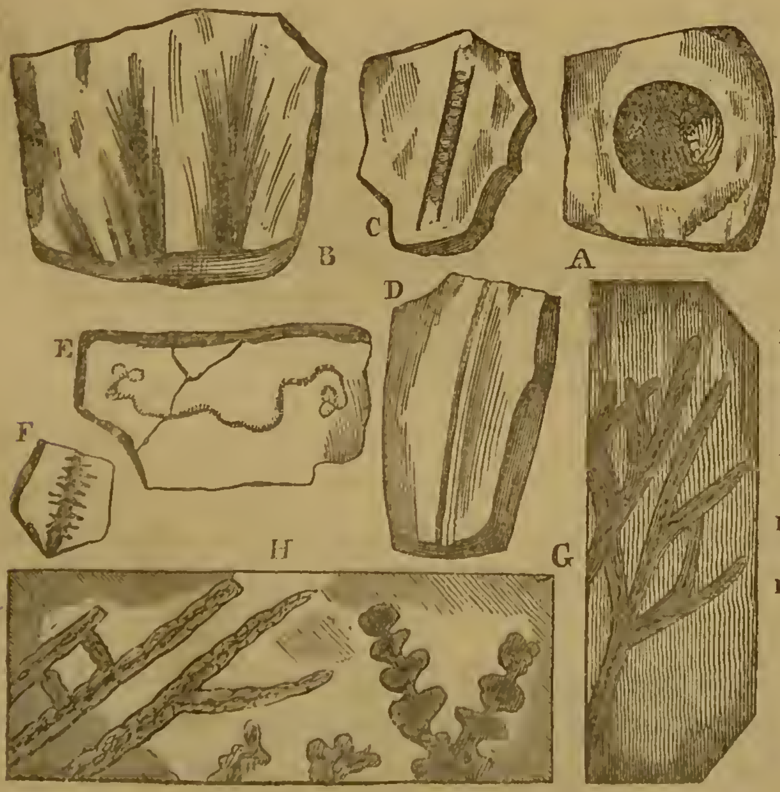
GEOLOGICAL DISTRIBUTION OF THE CONFERVALES.

(219.) The fossil Confervæ of the ancient world appear, by their geological position, as far as it is known, to confirm, in an extra-

ordinary and unexpected manner, the soundness of the conclusions at which naturalists had previously and unpremeditatedly arrived, as to the geographical distribution of the present existing species.

(220.) In the first place, they appear to have been much less common in former times than now, for in the older rocks no traces of them have been ever found, and in the second, to have been unknown during those epochs in which the temperature of the tropics extended further towards the poles. For the vestiges discovered in the upper secondary and tertiary formations are extremely few; and no decided evidence of their existence has hitherto been adduced, even so late as the era of the coal measures, when ferns and palms, and pines, were flourishing with the most exuberant wildness; for the filamentary productions found in the schistous deposits of the coal formations have, as Brongniart well observes, none of the characters of confervoid plants, but resemble more the impressions made by ulvaceous flags, or the aquatic rootlets of still superior vegetables.

(221.) The *Chalk-marl*, nearly at the summit of the secondary series, is the first stratum in which vestiges of decided confervoid plants appear; and here only two species, at most, have been found: these have been figured by Brongniart, in his "Histoire des Vegetaux Fossiles," and described under the names of *Confervites fasciculata*,



A. Confervites? Ægagropilöides (reduced.)
B. Confervites fasciculata.
C, D. Filaments magnified.
E. Confervites thoreæformis.
F. Portion magnified.
G, H. Confervoid markings in agate.

and *C? Ægagropiloïdes.* The first bears a very considerable resemblance to our present species, *C. ærea* [§ 175, fig. D.], and the latter to our moor-ball, *C. Ægagropila,* [§ 184, fig. A.] or rather to our sea-balls, *Ægagropilæ marinæ,* which are formed by the aggregation of the leaf fibres of Caulinia oceanica. Hence a query is affixed to its generic name; for, no articulations being perceptible, it is a very doubtful Confervites.

(222.) In the tertiary series, another species has been discovered, [§ 221, fig. E. F.], which Brongniart calls *Confervites Thoreæformis,* from its similitude to certain species of the recent genus *Thorea; e. g.* to the T. *ramosissima* of France, or rather to the T. *violacea* brought by Bory St. Vincent from the Isle de Bourbon. Brongniart states this to be the most satisfactory example he has seen of a fossil Conferva: the specimen from which his figure was taken is preserved in the collection of the Marquis de Dré.

(223.) The above-named two species of Confervites are all that have been hitherto discovered and absolutely determined; hence there are not sufficient materials collected to decide how far the various sections of the Confervales could be distinguished, if found in a fossil state. Such a distinction would certainly be difficult, Brongniart thinks almost impossible; at any rate, it would be useless now to subdivide so small a group: therefore, it is agreed that all articulated filamentous fossils shall for the present be associated together, and form the genus *Confervites,* which, should a greater number hereafter be discovered, may become the common name of the fossil section, equivalent to *Confervinæ* among recent plants.

(224.) That further researches will enlarge the group there can be little doubt, for Brongniart mentions having examined, in a collection at Verona, various fragments of marine fossils bearing the impressions of articulated plants, apparently Confervites, of several different species. One fragment, he says, seemed, from the rounded granules towards the ends of the filaments, to bear the impression of a plant similar to some of our modern *Ceramiaceæ,* and several others which were in too imperfect a state to be specifically described, he considered to be associates of the various genera of the same type.

(225.) Confervöid streaks have long been noticed in agates, as to them is owing much of the beauty of the stones; and Daubenton first suggested the idea of their being the vestiges of Confervæ.

Brongniart however believes these markings not to be impressions made by plants, but simple infiltrations. But Mr. M'Culloch and others support Daubenton's opinion that they are the traces of Confervæ, and it is very probable that at least some of them [see fig. G, H, § 221] have a vegetable origin. The above-named gentleman, in his very valuable paper, published in the 2d vol. of the Transactions of the Geological Society of London, in the section that treats of the markings in agates and other chalcedonies, observes, "Among them, however, will be found some exhibiting an organization so decided that no mode of crystallization, or inorganic arrangement, can be conceived capable of imitating it." And it must be confessed that the figures he gives bear out his assertions. In corroboration of this belief, it is also urged, that some species of *Confervales* inhabit hot springs, and that it is in hot springs, such as the Geysers, that silex is held in solution; but to this argument Brongniart replies, that the Confervales found in such localities belong to the type Oscillaceæ, which are, of all, the least like in form to the disputed markings of the agates.

(226.) Two additional supposed species have been figured by Schlotheim as belonging to the genus Confervites; but the one named by Agardh C. Schlotheimii is believed not to be a true fossil, but a modern plant; either a rootlet, or a *rhizomorpha*, that has penetrated a superficial schist; and the second seems to be rather a coralline than a conferva. A third species, figured by Jager, and described under the name of *Confervöides arenaceus*, has likewise been rejected from the genus, its characters being obscure, and its affinity extremely doubtful.

(227.) Thus the species of this order, which, by their fossil remains, have been decidedly recognised as denizens of the ancient world, are but two, and, even including the doubtful and undetermined markings, the amount still remains very small. So that either all vestiges of these plants, if they were formerly as abundant as they are now, must have been wiped out, which there is no reason for supposing, or the physical condition of this planet must formerly not have needed the services they now perform; or have been at one time incompatible with their existence, and at another unfavorable to their increase.

(228.) Thus the geographical and geological distribution of the Confervales curiously coincide, and the facts collected on either hand as curiously confirm each other. For, as in our own time, these plants abound in temperate regions and are unknown, or

few in warmer latitudes, so likewise in former eras, when, from other evidence, it is believed that the temperature of this globe was higher than at present, geological researches affirm that they were, in like manner, either absent, or as scantily produced.

(229.) Thus is the first link of an astounding chain of testimony secured; for, from the beginning, there were natural witnesses of Nature's works, and natural records kept; and these humble plants will perhaps afford one of those scattered sybil leaves, which, if rightly arranged, may unfold, in part, the ancient history of the world.

FUCALES.

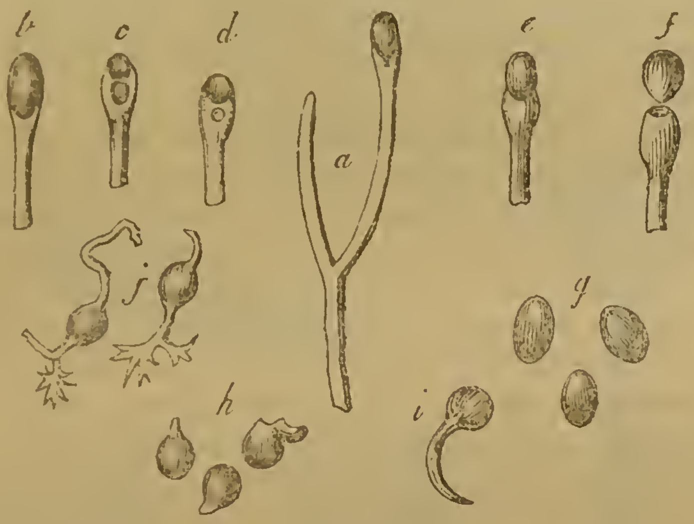
(230.) The Lavers or washworts (*Ulvinæ*), with the curious river-wrack (*Lemania*), and the sea-weeds or wrackworts (*Fucinæ*), shew in their several types and species, still further progressive stages of development, and modifications both of external and internal structure. The slimy thallus is in them generally absent, or, if present, seldom observable. Sometimes, as in the *soft skin* (*Codium*), it is altogether obsolete; these plants being, as Greville states, totally destitute of epidermis: and in others, though present, it is for the most part very obscure, having become a mere film, and often being undistinguishably blended with the more or less condensed series of cells that constitute the membranaceous, cartilaginous, and coriaceous teguments, of a vast majority of the species.

ULVINÆ.

(231.) SIPHONACEÆ. On the confines of the preceding and of the present orders, there are certain plants which may be termed transitional; once indeed they were esteemed *Confervæ*, and placed in the genus *Ectosperma*. But although more accurate observations have shewn them not to be confervine plants at all, as formerly supposed, still they are evidences of the connexion between the (*Ceramiaceæ*) vase-worts, of the Confervinæ, and this first type of the *Ulvinæ*, or Lavers, amongst which they are now arranged.

(232.) In honour of M. Vaucher, a most meritorious Algologist, the first genus in the type, has been named *Vaucheria:* and the clubbed-tipped species (*V. clavata*), if no fallacies vitiate the accounts given of it by Unger, is one of the most paradoxical plants existing; for, notwithstanding its distance from the Zoocarpes, it resembles, in some of its transitional metamorphoses, those very curious fruit animalculæ.

(233.) The account given by Unger is shortly this:—That the club-shaped reproductive vesicles that terminate the divisions of the plants, when separated from the fronds on which they grow, swim about like animals possessing sensation and volition. And, furthermore, that after exhibiting this restless activity for nearly



(*a*) Portion of Vaucheria clavata, in fructification.
(*b*, *c*, *d*, *e*, *f*) a series of views of the fructifying summit, shewing the gradual expulsion of the contained globule. (*g*) Globules as they appear in their animated state. (*h*, *i*, *j*) Globules germinating and commencing the vegetable term of their existence.

an hour, they lose their seeming animality, become torpid or stationary, and in a short time put forth first a radicle, then a stem, attach themselves to the nearest substance, grow like plants, and in about eleven days arrive at maturity, bearing animalcular fruits similar to those from which they sprang. These observations, singular as they seem, M. Unger says, he made repeatedly with the same results.

(234.) Unger's account of his observations upon the natural history of this plant, are too curious not to be given, as far as possible, in his own words. I therefore quote, with occasional necessary abridgments, the translation of his memoir, with the figures which appeared in the fourth number of the Magazine of Natural History.

(235.) He says, that "on the 5th of March he found near Vienna, in a ditch containing some clear water, derived from the melting of snow, a Conferva, which in four days produced fructification, and he knew it by the green globular summits to be the *Conferva dilatata* of Roth; *Ectosperma clavata* of Vaucher; or *Vaucheria clavata* of the present day.

While watching attentively the growth of this plant, he perceived that the globule, which terminated one of the filaments, "became gradually darker in its colour, and a little transparent at its extremity; in the middle it was evidently

somewhat contracted, and had some trace of spontaneous motion." He then continues: "I could scarcely believe my eyes when I perceived the contraction to become more decided, and a cavity to be formed at the base. The contraction at length divided the globule into two smaller globules, which moved spontaneously towards the summit. As the developments proceeded, the cavity of the uppermost globule became enlarged, while the inferior globule diminished. The latter at length disappeared, and the remaining large globule escaped by a terminal orifice, ascending till it reached the surface of the water. The whole of this process occupied about thirty seconds; but from subsequent observations it may be stated generally to take up a minute.

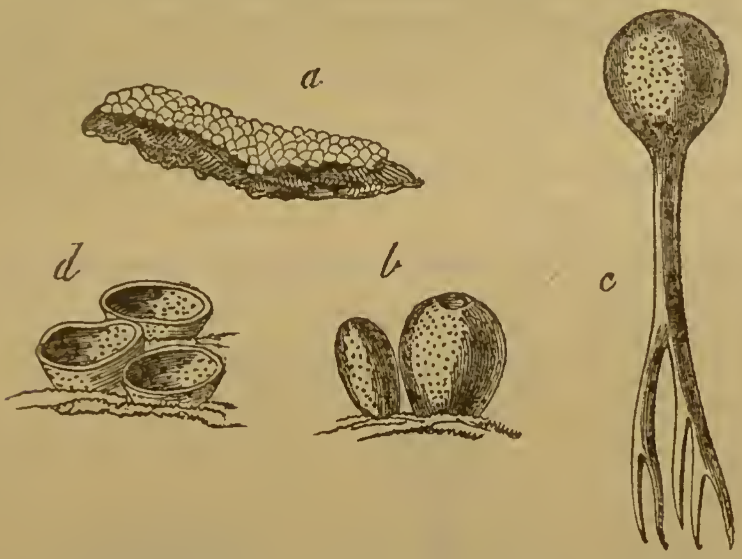
"As I continued my observations, I happened to look at the surface of the water, and was not a little astonished to find it covered, especially towards the side of the vase, with minute globules, unequal both in colour and size. Many of them swam freely here and there, moving at their option, in one way or another, retiring and approaching one another, gliding round globules that were motionless, stopping, and again setting themselves in motion exactly like animated beings. Conjecturing the identity of the green globules that possessed motion with those that had none, I immediately began to examine whence these infusory animalcules derived their origin, and what relation they bore to the green globule and the fructification of the conferva.

"The next day I perceived a great number of the globules aggregated around the bubbles of gas, disengaged from the conferva, and floating at the surface. There were some of them of a dark-green colour, and either round or elongated; others more transparent, tumid, and with one or two appendages diverging from or at right angles with each other; these were evidently plants in a state of germination; other globules again were oval, very dark at one extremity, and almost transparent at the other; these swam about freely. Within the space of one hour, I succeeded in tracing not only the diminution of vitality and death of the infusoria, but also the subsequent development of the dead animals into germinating plants, in such a manner as to establish the truth of the fact. But on the 12th of March, I had the pleasure of ascertaining distinctly the origin of these minute bodies. I undertook to observe, without interruption, one of the tubercles of fructification which I have already mentioned as terminating the filaments, in order to discover what became of the green matter enclosed within it. I had observed it for the space of half an hour, when the series of changes just detailed commenced, and the previous observations were indisputably confirmed. Towards the close of their hour of animal existence, the globular form of these corpuscules becomes elongated, and this change of form, with an equal diffusion of the green colouring matter, are the first signs of this epoch of their life drawing to a close. In about six hours the globule has become much more transparent, and puts forth an appendage, and, on the third day, a second one, by which the young plant becomes fixed to the side of the glass vase, or any other body in contact with it. About the eleventh day the fructification of the new plant is apparent at the summit of the principal branch, and the cycle of events is repeated as before."

(236.) The histories of other *Vaucheriæ* are much less extraordinary than Unger's account of the Vaucheria clavata. Their fronds are continuous capillary tubes, containing multitudes of

dark-green granules attached to the hollow stems and branches, and producing fructifying conceptacles on various parts. These are well figured by Greville, in his beautiful work on the British Algæ, in which he has completely reduced this once obscure and difficult order to the rule of system. As far as possible the present sketch shall be made to coincide with his arrangement, and his lucid definitions will in general be adopted.

Botrydium granulatum.



(*a*) Group of plants, natural size. (*b*) Plants growing, magnified. (*c*) Entire plant shewing its root. (*d*) Old plants collapsed.

(237.) The *Botrydium* or *grapelet*, (*Grev. Alg.* pl. xix.) is perhaps the most simple of the section, for it appears to consist of but one conceptacle, containing a watery fluid; after the contents of the vesicles are discharged they become cup-shaped, and being crowded together in large patches, resemble the thin crust of an order, hereafter to be described, under the name of *Lichens.* But although the superior axis of these plants is abortive, the inferior is produced in the form of a fine root, the length of which often exceeds the diameter of the conceptacle four or five times.

(238.) The *Sea purse* (Codium Bursa), is a rare and curious example of this group. It is a hollow, subglobose plant, somewhat resembling a gigantic Botrydium without a root. Its attachment to rocks is but slight, and when found it is generally free. (Vide *Turner's Fuci*, t. 136.)

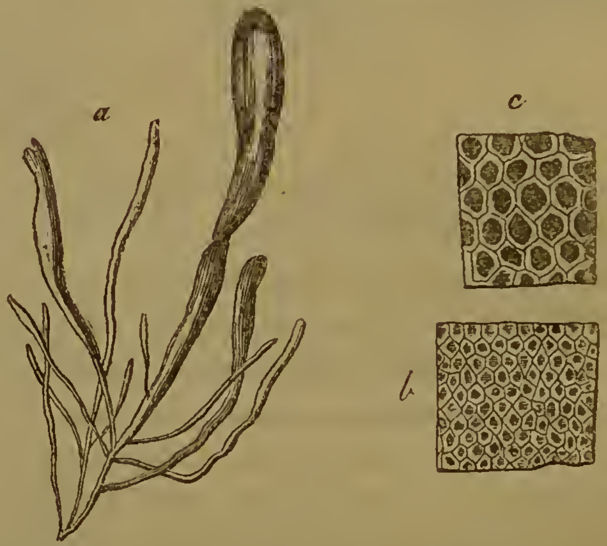
(239.) These, with several other similar vegetables "of an herbaceous green colour, growing either on damp ground, in fresh water, or in the sea," are associated to form a type, called, from the normal genus, *Siphonaceæ.* The following are the chief cha-

racteristics of the group, whether synthetically or analytically considered: " Fronds membranaceous and continuous; figure various, composed of simple or branched tubes, globular, cylindrical, or flat, solitary, or collected into a lax spongy mass; fructification, as in the Ceramiaceæ, external, and consisting of vesicles (sporidia) filled with dark-green granules (sporæ.)"

(240.) Greville calls this group *Siphoneæ;* but, as it is very desirable that the names of all the types and sections should have similar terminations, as indicative of similar stages of analysis, it may probably be deemed excusable to change it to *Siphonaceæ*, which word will better correspond with Ulvaceæ, Fucaceæ, &c. names already established; the termination *-idæ* or *-eæ* being reserved to indicate the subtypes, whenever they are required to be noted.

(241.) *Ulvaceæ.* The Enteromorpha, or *water-gut*, [*Grev. Alg.*, pl. xviii.] receives its name from the intestine-like appearance of

Enteromorpha compressa.



(*a*) Entire plants. (*b, c*) Portions magnified to shew the cellular structure.

the fronds, some of which are round, some flattened, and some puckered, as if attached to an invisible mesentery.* The *ulva*, or true *water-wash*, shews in its different species the various degrees of compression that the tubular frond undergoes until the cavity is obliterated, or filled with cells. *Ulva crispa* and *bullosa*, the bladder and curled lavers, being hollow and inflated, the *ulva*

* The fronds vary in length from a few inches to three feet, and when distended with water, very much resemble the intestines of an animal floating in the stream.

actuca, or lettuce laver, partly plane and partly inflated, while the *ulva latissima*, or oyster-green, spreads abroad a wide flat frond. So abundant are these plants in many places, that they become a serious obstruction to the fishermen, by clogging their nets. The ulvæ are always green, and hence they are with facility distinguished from the *Porphyræ*, or *slokes*, which are more commonly brought to table under the name of lavers than those plants to which the term *ulva*, as now restricted by botanists, is legitimately applied. But all are frequently eaten, and the one substituted for the other; and even the ulva compressa, which is disregarded by us, is esteemed as a food by the natives of the Sandwich Isles.

Some ulvæ are remarkable for the high temperatures they will endure, growing as they do in hot springs, *e.g.* U. thermalis flourishes in those of Gastein, the heat of which is about 117° of Fahrenheit.

(242.) The *Porphyræ* are distinguished from the other ulvaceæ by their purple colour; they contain much viscid gelatine, and are very nutritious; nevertheless, although abundant, they are rather regarded as luxuries than as common articles of food; and are seldom met with but at the tables of the great: *Porphyra laciniata* and *P. purpurea*, are the species most frequently collected.

(243.) The *Porphyræ* or slokes, the *Ulvæ* or lavers, and the *Enteromorphæ* or water-guts, with other similar plants, constitute together another type belonging to the same section, which, as they were formerly all called *ulva*, and as ulva must still be regarded as the normal genus, are collectively denominated *Ulvaceæ*, or laver-worts. This type is easily distinguished from the Siphonaceæ, or lather-worts, the only other one with which it can be confounded, by having the spores internal, while in *Siphonaceæ* the conceptacles are without the general mass of the frond ; and hence the Ulvaceæ have been sometimes called the *Entospermeæ*, while the siphonaceæ might be named, from the contrary character, *Ectospermeæ*. Like the *Siphonaceæ*, they are both terrestrial and aquatic plants, some growing on damp ground, and others either in fresh water, or in the sea; many of them abound in the mouths of rivers, and in salt water ditches. The frond, which is either flat or tubular, has a very small scutum or shield-like base, and the imbedded spores often assume a quaternary arrangement.

(244.) LEMANIACEÆ. The curious *Lemania*, or river-wrack, at one time arranged with the *Confervæ*, and at another with the *Fuci*, appears rather to be an associate of the *Siphonaceæ* and *Ulvaceæ*, and to form the link of connexion between these types and the following section. The structure of this singular genus, *i. e.* the leathery consistence and olive hue of its continuous non-articulated frond, will demonstrate its affinity to the *Fucinæ*, but in habit it totally varies from all known genera of that, or the allied section, the *Florinæ;* for while they are invariably marine plants, the Lemaniæ are exclusively confined to fresh water, delighting in mountain torrents and impetuously running streams. The fructification is likewise peculiar, consisting of moniliform articulated sporidia, growing from the internal surface of the tubular frond, or within enlarged cellules, obscurely visible from without. The sporidia separate when mature, and germinate. Agardh, acting on the general acknowledgment of these peculiarities, has very properly made it the type of a separate group; and in this he is followed by Hooker, and most other botanists, who adopt his definition of the type.

(245.) The *Siphonaceæ*, *Ulvaceæ*, and *Lemaniaceæ*, form collectively the section called, from the most important and best known type and genus, the ULVINÆ. The affinities of this group with the preceding order are twofold, for the *Entospermatous Ulvaceæ* are allied especially with the *Entospermatous Confervaceæ;* and the *Ectospermatous Siphonaceæ* with the *Ectospermatous Ceramiaceæ;* the whole series being removed from the CONFERVAS, and at once distinguished as a section of the order FUCALES, by their continuous non-articulated fronds.

(246.) The connexions of the Ulvinæ with the following order is necessarily of a closer kind, but their membranaceous fronds afford in almost every case a sufficient diagnosis; and whenever, as in *Lemania*, the connecting genus, this character fails, their internal fructification and fresh water habitat will at once separate any doubtful species from the Florinæ and Fucinæ, which are universally marine.

FLORINÆ AND FUCINÆ.

(247.) In the *Ulvinæ*, the cells of which the plants are composed, when not naked, as in *Codium*, are in general covered by a

delicate reticulated membrane, which is seldom met with in a coriaceous state; but in the following sections, *Florinæ* and *Fucinæ*, which are all sea-plants, the tegument becomes more and more firm, proceeding from the membranaceous texture of *Halymenia*, the sea-film, to the gristly and the leathery coverings of the *Chondrus*, or sea-gristle, and *Himanthalia*, or sea-thong.

(248.) These plants likewise shew the scheme of its formation, and the distinction of the cellules, according to their compression and condensation into different textures, the inner loose cellular structure into which fluids are absorbed being termed the *Enchyma*, and the tegument enclosing the whole the *Ep-enchyma*. The first has commonly been denominated the pulp or *par*-enchyma, but, from the circumstance of there being several forms of pulp, and *par*-enchyma being but one modification, while *pros*-enchyma is another, *Enchyma*, or simply pulp, may be the better collective term, [§ 253, 258.]

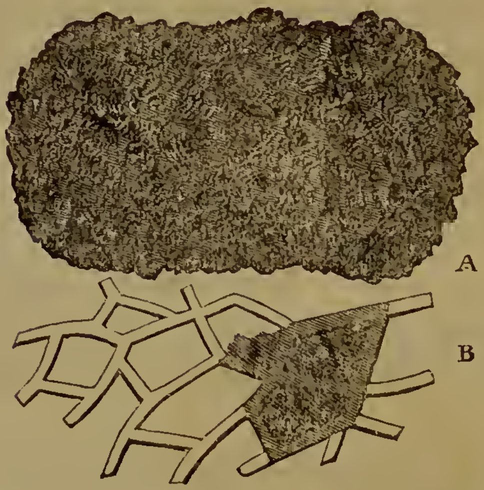
(249.) The tegument likewise is not here a cuticle, and the old name, *epi*-dermis, is certainly untenable in these cases, where there is no *dermis*, or skin, for it to be upon. The formation of this *ep-enchyma*, by the compression of the cells of the *enchyma*, is well seen in a section of the *Catenella*, or chain-let, and many others, [vide § 254, 259, &c.]

(250.) The British seas afford examples of most of the types of these two very extensive sections, which, although intimately allied, have been, from the colour of the fronds, distinguished into two groups, the *Florinæ* and the true *Fucinæ:* the first of which are of a membranaceous or cartilaginous structure, and seldom change much in drying; the second, or true *Fucinæ*, are more or less densely fibrous, and mostly become of a dingy black when dried. In the fresh state likewise, the *Florinæ* have showy pink or purple fronds, the sporidia being also purple, while in the *Fucinæ* the fronds are of an olive-green, and the sporidia black. These characters, however, which in general hold good, admit of some exceptions, as indeed do all natural definitions, if they attempt to *divide* continuous series, when the object should rather be, even when analysing and distributing the genera in groups, to point out their various connexions.

FLORINÆ.

(251.) Of two out of the six types into which the *Florinæ* are distributed, there have not as yet been found any examples in the British Marine Flora, viz. of the *Thaumasiaceæ*, or wonder-worts, and *Caulerpaceæ*, or creeper-flags; but these two sections each contain only one known genus.

(252.) Caulerpa, the creeper-flag, is characterised by its greenish membranaceous frond, with creeping offsets from the root, It is a native of the equatorial seas, and is also found on the southern coasts of New Holland, [vide fig. A. B, § 259.] Thaumasia,



Thaumasia ovalis.

A. Entire plant reduced.
B. Portion magnified, to shew the retiform skeleton with its investing membrane.

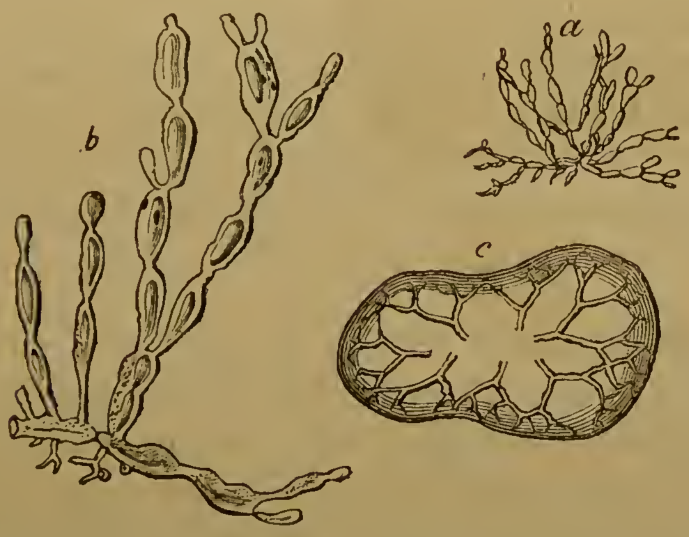
or the wonder-wort, is equally well distinguished by its extraordinary skeleton. The only figure I have been able to find is that given by Agardh, in his " Icones Algarum," and from it the accompanying sketch is taken. Agardh says, " This genus is of so singular a nature, that it is difficult to say whether it should be arranged among the Zoophytes or the Algæ. It is an alga with a skeleton, the skeleton is that of a zoophyte, but the softer parts are those of a flag. The skeleton or frame-work consists of meshes formed of hard filaments about the size of a hog's bristle, rigid, fragile, and of a shining brown colour; internally they are solid, not tubular. The foliaceous substance with which the network is overspread, is thin, flexible, and blackish, rather resembling the fronds of Rhodomela, [§ 259.] Agardh concludes, by observing, that it will be seen, from the above description, that he is fully justified in giving it the name of *Thaumasia*, *i. e.* wonder-

wort. The specimen sent to him and figured, being of an oval shape, he has added *ovalis* as the specific denomination. This plant was found by Konig, in the roads near Ceylon. Linnæus called it *Fucus flavus.*"

(253.) The *Gastrocarpaceæ*, [*Grev. Alg.* pl. xvii.] known by their ribless veinless fronds and cellular epenchyma, enclosing a gelatinous Enchyma in which the sori are imbedded, contain the *Irideæ*, or dulses, one, if not more species of which, as the *Iridea edulis*, is a favorite food with many crustaceous animals, as lobsters, crabs, and cray-fish: it is likewise eaten by fishermen, both raw and roasted. When properly dressed, it is said to taste like roasted oysters.

(254.) Here also will be found the *Catenella opuntia*, or the

Catenella opuntia.



(*a*) Tuft of plants, natural size. (*b*) Plants separated. (*c*) Transverse section of frond, to shew its internal structure.

chainlet, and likewise the Halymeniæ, or sea-membranes, one of which, the dulse (*Halymenia* or *Rhodomenia palmata,*) was formerly dried and chewed as a luxury by the Scotch and Irish; it has the flavor of violets, and is very pleasant in the mouth; but, as Johnston observes, it has now been almost supplanted as a masticatory by the less agreeable tobacco. It is still however, in a raw state, occasionally eaten by the common people, from a belief in its being a sweetener of the blood, and a remedy for scorbutic complaints. "There is," says Mr. Neill, "a common saying in Stronsa, that he who eats of the dulse of Guiodin, and

drinks of the wells of Kildingie, will escape all maladies except black death."

(255.) To the Icelanders, H. palmata is a plant of considerable importance. They prepare it by washing it well in fresh water, and exposing it to dry, when it gives out a white powdery substance, which is sweet and palatable, and covers the whole plant; they then pack it in casks to keep it from the air, and thus preserve it, ready to be eaten either in this state with fish and butter, or, according to the practice of wealthier tables, boiled in milk, and mixed with a little flour of rye. The cattle are also very fond of this sea-weed, and sheep are said to seek it with such avidity as often to be lost, by going too far from the land at low-water."—*Quart. Rev.* vii. 68.

Hence it has sometimes been called *Fucus ovinus*, or sheep-dulse: the name dulse (*q.d.* dulcis) having reference, doubtless, to its sweet taste. This species (R. palmata) is the true " saccharine fucus of the Icelanders, and is consumed in considerable quantities, not only in Iceland, but also throughout many of the maritime countries of the north of Europe, and in the Grecian Archipelago." *Grev.* In Kamtschatka it is fermented by the natives, its saccharine matter being so abundant that it affords them an exhilarating beverage.

(256.) The *Floraceæ* are distinguished by their brilliant and little changing tints, their foliaceous fronds, and the segregation of their spores in conceptacles or sori; or, if scattered, by their assuming a ternate disposition, the *Rhodomela*, or rose-black, the *Laurencia pinnatifida*, or pepper dillosk, and the *Chondrus crispus*, or carrageen-moss, are good and familiar examples of this section. The former used to be eaten in Scotland; and in Ireland the latter is still collected for food. Lately, indeed, it has found its way to the London markets; and it is preferred by some persons to the so-called Iceland moss. It contains an abundance of mucilage, and is employed by frugal housewives as a substitute for isinglass, in the manufacture of blanc-mange and various jellies. Steeping it for sometime previous to boiling, is said to remove its bitter flavor; which, however, as a slight tonic, is one recommendation to its use in consumptive cases.

(257.) A tropical Gelidium, some species of which genus inhabit our seas, is said to be the substance collected by the swallows,

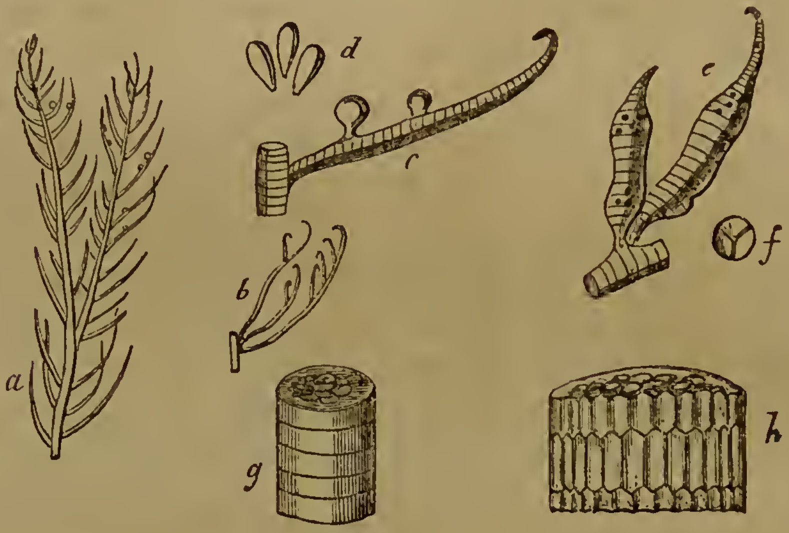
and used in the construction of the edible nests of Java. The taste for birds' nests as an article of food, strange as the fashion may appear to us, is so strong in China, that their collection and importation employs a vast number of persons, and forms a very important and lucrative branch of commerce. It has been estimated that 242,400lbs. of birds' nests, worth there £234,290. and upwards, are annually exported from the Indian Archipelago. "The only preparation the birds' nests undergo is that of simple drying, without direct exposure to the sun; after which they are packed in small boxes. They are assorted for the Chinese market into three kinds, according to their qualities; and the common price for birds' nests of the first sort at Canton, is no less than 3500 Spanish dollars the pecul, or £5. 18*s.* 1½*d.* per lb.; for the second, 2800 Spanish dollars the pecul, and for the third, 1600." From these prices, it is evident that the birds' nests can be no more than an article of expensive luxury. They are consumed only by the great; and indeed, the chief part is sent to the capital for the consumption of the court; and, such is the extraordinary demand for this description of food, and so enormous the price, the best being sometimes worth nearly their weight in gold, that in China, to say that a man eats birds' nests, is equivalent to saying that he is a grandee, or a person of great opulence.

(258.) The collecting birds' nests appears from Mr. Crawford's account, to be as perilous a toil as our fearful trade of gathering samphire; for he says, the nests are obtained in deep and damp caves, and are most esteemed if taken before the birds have laid their eggs. The coarsest are those collected after the young have been fledged. The finest nests are the whitest, that is, those taken before they are defiled by the young birds. They are taken twice a year, and if regularly collected, and no unusual injury offered to the caverns, the produce is very equal, and the harvest very little, if at all, improved by being left unmolested for a year or two. Some of the caverns are extremely difficult of access, and the nests can only be collected by persons accustomed from their youth to the office. In one place the caves are only to be approached by a perpendicular descent of many hundred feet by ladders of bamboo and rattan, over a sea rolling violently against the rocks. When the mouth of the cavern is attained, the perilous office of taking the nests must often be performed by torch-light,

by penetrating into the recesses of the rock, where the slightest trip would be instantly fatal to the adventurers, who see nothing below them but the turbulent surf making its way into the chasms of the rock.—*Crawford's Eastern Archipelago.*

(259.) The *Rhodomela* pinaströides, or rose-black, is a very

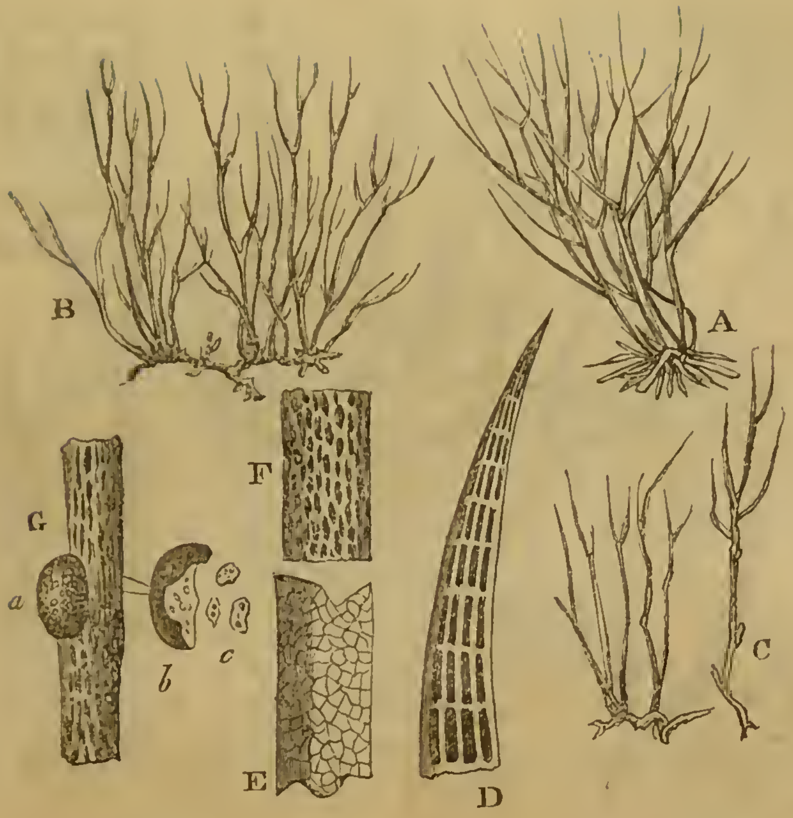
Rhodomela pinaströides.



(*a*) Branch with round conceptacles. (*b*) Ditto with long conceptacles. (*c*) Piece of *a*, magnified. (*d*) Spores, (*e*) Long conceptacles containing ternate granules. (*f*) A ternate granule. (*g*) Portion of frond, to shew its pseudo-articulated appearance. (*h*) Section to exhibit internal structure, and shew on what the pseudo-articulated appearance depends, viz. the parallelism of the cellular structure.—*Grev. Alg.* pl. xiii.

elegant illustration of this type, and the Corsican worm-grass, *Gigartina* (or sphærococcus) *Helminthocorton*, is another example. The latter grows abundantly in the Mediterranean, and is celebrated on the Continent as a vermifuge, under the name of Coralline of Corsica. It has also been recommended as a remedy in cancer. In this country it is scarcely ever used.

The *Plocamium*, or hair-flag, is too beautiful an example of this type to be passed unmentioned. Its collection and preparation afford employment, and yield no inconsiderable profit to many poor people on our coasts. Its elegant varieties in form, and brilliant colour, have rendered it a universal favorite. It is the weed chiefly used in the construction of landscapes, once a fashionable art, though not now in vogue.



A, B, C. Plants of Gigartina Helminthocorton, natural size.
D. Summit of a frond magnified. E, F. Portions still further magnified. G. Portion with fruit. (*a*) Tubercle of fructification. (*b*) Conceptacle open, and spores discharged. *Nees v. Esenbeck.*

(260.) *Spongiocarpaceæ* and *Furcellaceæ.* The genera *Polyides*, or sea wort-reet, and *Furcellaria*, or sea fork-let, each consisting of but one known species, mark the transition by their structure from the *Florinæ* to the *Fucinæ;* and although of each there is but one known species, yet so different are they from each other and from the rest of the Algæ, that both genera have been very properly separated by Greville and made typical of independent groups, the first being called *Spongiocarpaceæ*, and the second, *Furcellaceæ*, [§ 262, fig. C, D.]

(261.) *Spongiocarpaceæ.* The colour, habit, and general structure, indicate the affinity of the *Spongiocarpaceæ* with the *Floraceæ*, but the naked spongy wort-like sori of Polyides, formed by clusters of wedge-shaped sporidia intermixed with radiating filaments, at once distinguish it from that, as well as from all other sections, [vide § 262, fig. D.]

(262.) The *Furcellaceæ* are likewise as well distinguished; for,

A. *Caulerpa pinnata.* (*a*) Creeping root. (*b*) Portion magnified. (*c*) Pinna marked with spots.

B. *Caulerpa taxifolia.* (*d*) Shoot rising from the creeping fronds. (*e*) Portion magnified. (*f*) Pinna, separate and enlarged.

C. *Furcellaria lumbricalis.* (*g*) Entire plant. (*h*) Fructification in apex of frond. (*i*) Longitudinal section of ditto. (*j*) Horizontal section. (*k*) Spores.

D. Polyoides rotundus. (*l*) Plant with Fructification. (*m*) Apex with fruit removed. (*n*) Transverse section. (*o*) Spores. (*p*) Sporidia mixed with fibres.

although the appearance of *Furcellaria* [vide fig. c.] is something approaching to the *Fucinæ*, and although like them it is of a less brilliant colour than most of the *Florinæ*, and becomes darker on exposure to the atmosphere, still its fronds are not fibrous; and its terminal conceptacles, with horizontal circular strata of dark oblong-pearshaped spores, will distinguish it sufficiently from the beforenamed sections.

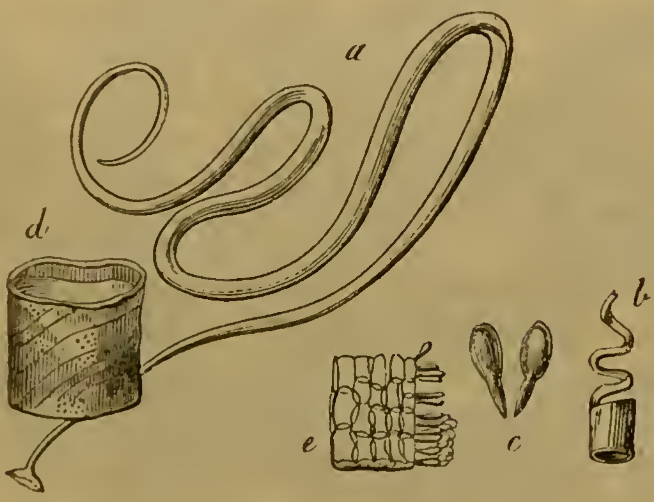
(263.) Collectively, the types *Furcellaceæ*, *Spongiocarpaceæ*, *Floraceæ*, *Thaumaceæ*, *Gastrocarpaceæ*, and *Caulerpaceæ*, form the extensive section *Florinæ*, which with *Fucinæ* immediately to

be described, and *Ulvinæ* previously examined, constitute an order sometimes called pre-eminently *Algæ*, sometimes *Phycæ*, sometimes *Thalassiophytes*, or Thalassiophycæ, but for which, a word either compounded of the two most important sections, types, and genera, or derived from one of them, would be a preferable name, [§ 289.]

FUCINÆ.

(264.) DICTYOTACEÆ. The sea networks, forming the first type of this section, are well characterised by the beautifully reticulated texture of the tegument, whence indeed the name *Dictyotaceæ*, which has been given to the group, from its normal genus *Dictyota*. The fronds are of various forms, but in all, excepting *Halyseris*, the sea-endive, ribless; and the conceptacles are pellucid, inclosing the sporules, which are for the most part produced beneath the epenchyme.

(265.) The Peacock's tail, or *Padina pavonia*, affords a beautiful example of this section; but *Chorda filum*, sea-whiplash, or



(*a*) Chorda Filum. (*b*) Portion of frond artificially unrolled to shew its spiral structure. (*c*) Spores magnified. (*d*) Portion in fructification. (*e*) Section, to shew internal structure.

sea-catgut, is perhaps a more familiar instance. This plant is often found thirty or forty feet in length, and Lightfoot says, the Highlanders twist it, when skinned, into fishing lines. And so abundantly does it sometimes grow that, as Mr. Neill declares, it is with difficulty a pinnace can make its way through oceanic meadows of this weed.

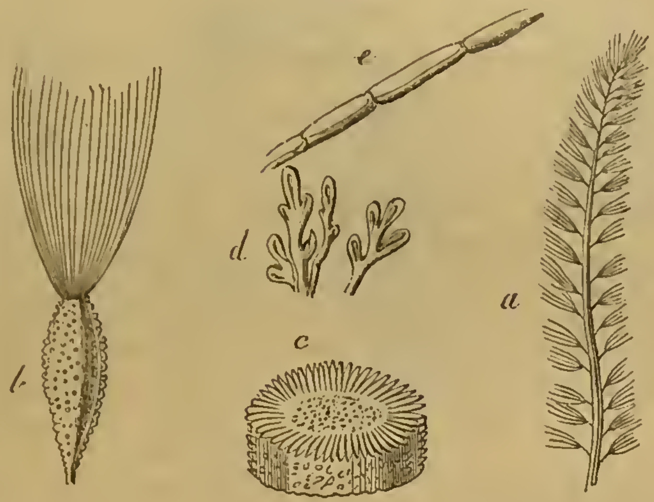
The frond of this cord-like flag is hollow within, and the channel interrupted at short distances by transverse partitions, the use of which, according to Colonel Stackhouse, is to confine the air, or elastic vapour, to certain spaces; so as to act like swimming bladders and increase the buoyancy of the plant, which extends itself to such an amazing length, and always shoots upwards to the surface.

(266.) The smell of (Halyseris) the sea-endive, the only genus with a ribbed frond, is said to be, " when fresh gathered, extremely powerful and disagreeable."

(267.) *Chordariaceæ.* The *Chordaria*, or sea-whipcord, which differs from all other Algæ by its *solid* filiform cylindrical frond, even although the fructification is very imperfectly known, has been arranged in a separate section by Greville, who thinks, " its singular structure removes it from all the other orders;" and hence it is the only known example of the *Chordariaceæ*, or twine-wracks.

A. *Macrocystis pyrifera.* B. *Laminaria buccinalis.* (*a*) Transverse section of stem. (*b*) A portion magnified, to shew structure. C. *Chordaria flagelliformis.* (*c*) Transverse section of frond with fruit. (*d*) Fibres and sporidia. (*e*) Spores still further magnified. (*f*) Longitudinal section of frond magnified.

(268.) *Sporochnaceæ.* Another type of this section, the *Sporochnaceæ,* which contains the genera *Sporochnus,* or scatter-tuft,

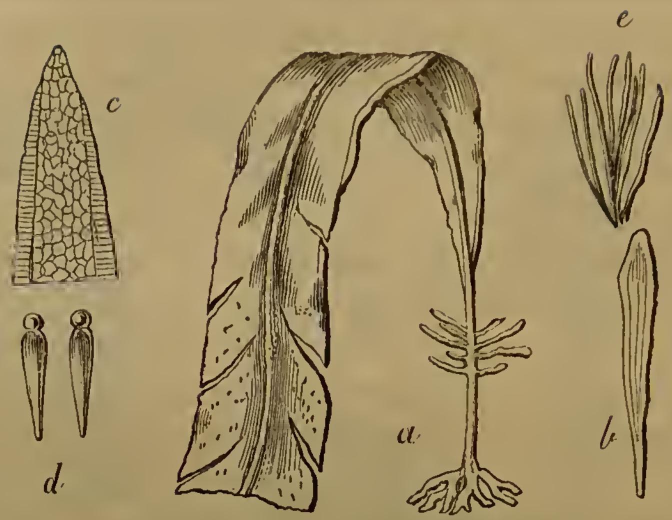


(*a*) Sporochnus pedunculatus, natural size. (*b*) A receptacle terminated by its tuft of filaments. (*c*) Section of the receptacle. (*d*) Filaments with their fertile summits. (*e*) Portion of a filament of the receptacle.

Dichloria, or changeling, and a genus named in honour of Desmarest, *Desmarestia* or *Desmia,* is chiefly characterized by bearing little tufts of fine green filaments on the fronds, but which are deciduous in some, and not yet observed in all the species. The fructification is collected in tubercles, either stalked or sessile. These plants, which are all marine, and of an olive or yellowish green colour, although they do not change to black in drying, become flaccid on exposure to air, acquiring a verdigris colour, and then possess the curious property of rapidly decomposing other delicate Algæ in contact with them.—*Grev.*

(269.) The sea-belts, or sea-girdles (*Laminaria*), the murlins, honey-ware, or bladder-locks (*Alaria*), with the interminable (*Macrocystis*), [§ 267, fig. A.], or bladder-thread, form, with a few other allied genera, such as *Durvillæa, Lessonia,* and so forth, a very natural and well-marked type, called, from their flattened form, and from *Laminaria,* or tangle, the name of the normal genus, *Laminaceæ,* or tangle-wracks; by Bory St. Vincent and Greville they are denominated Lamin*arieæ*; this termination, however, as in the other cases where a similar alteration has been made, is only changed from the manifest expediency of designating similar grades of analysis by somewhat similar words.

Alaria esculenta.



(*a*) Immature frond. (*b*) Fructiferous leaflet, of a mature plant. (*c*) Section, to shew internal structure. (*d*) Spores. (*e*) Filaments issuing from minute pores in the frond. *Grev. Alg.* iv.

(270.) The *Laminaceæ*, or tangles, are all marine, and their structure densely fibro-cellular; the fructification is collected in *sori* on the surface of the frond, which rises from a more or less divided rhizoma, and forms a longer or shorter stipes terminating in a plane expansion, either entire or divided; and sometimes ribbed. These plants are chiefly coriaceous, occasionally membranaceous, and become but little changed in hue on exposure to the air.

(271.) The frond of Laminaria esculenta varies from six to twenty feet in length, with a midrib extending the whole way. The midrib, stripped of its membrane, is the part preferred as food; but in some places, particularly in Orkney, Neill observes, that, the pinnæ are also eaten under the name of 'mirkles,' or murlins; they are said to be pleasant, but to leave, when chewed in any considerable quantity, a tenacious crust on the roof of the mouth which, while it remains, is very disagreeable.—*Drummond.* It is recommended in the cure of a disorder called pica, to strengthen the stomach and restore the depraved appetite to a healthy state. —*Hooker.*

(272.) *Laminaria saccharina*, or the sugar-sea-belt, has been said to be eaten by the Icelanders; and by some it is reported, that in Norway the cattle feed on it; but Wahlenberg declares, "that cattle will not touch it, and that its common name in Nordland is *Troll-tare*, which signifies that it is only fit for the sea-

devil. This diversity of opinion is probably owing not so much to difference of taste, as to the fact of the Laminaria saccharina, not being the Icelandic eatable, fucus saccharinus, which is the Rhodomenia palmata already described, the two having been frequently confounded." Thunberg tells that "in Japan it is prepared in such a manner as to be quite esculent, and that it is customary there, when presents are made, to lay upon them a slice of this fucus attached to a piece of paper folded in a curious manner, and tied with threads of gold and silver."—*Hooker*.

(273.) All the species, however, though not good as food, form excellent manure; and the farmers on our coasts avail themselves of what they call sea-furbelows and furbelowed-hangers, to enrich their lands.

Laminaria digitata, or sea-wand, is still, according to Greville, eaten in Scotland, and cried about the streets of Edinburgh as *tangle*. When cooked, the young stalks are not unpleasant; and in some places cattle are also fed on this plant when it has been boiled. The stipes, says Neill, are sometimes made into knife handles, which, after a few months' exposure to the air, become hard and shrivelled, and scarcely to be distinguished from hartshorn.

Johnson, in his Berwick Flora, states that "the *Laminaria digitata*, in some places of the western islands of Scotland, forms even a sort of soil on the pebbles of the beach, on which the poor natives sow barley; and as the sea-weed rots, the grain drops with it into the interstices, so that, when the harvest is ready, it is seen growing on a surface of naked polished pebbles." Sea-weeds, especially some of the Fucaceæ, as F. serratus, are found by experience to form an excellent manure for grass-lands, which yield abundant crops of hay if overspread with cart-wrack, as the husbandmen call it, during the winter. Captain Carmichael also says, that it is peculiarly adapted to potatoe culture; but that its application should not be deferred till the time of planting, as then the tubers are apt to become watery and ill-flavoured.*

*"A very curious circumstance is mentioned by Charles Mackintosh, Esq., who tried the effects of kelp manure upon potatoes, at Crop-basket, near Glasgow. A severe frost, which occurred in September, injured and blackened every lot of potatoes to which the kelp had not been applied, while the kelp lots remained in perfect foliage, even when the respective drills were contiguous. It would appear that the soil, for the time being, had acquired a property equivalent to a certain degree of atmospheric temperature, or, rather, that the nourishment absorbed by

(274.) In some of the Laminaceæ the stipe is hollow, which circumstance, as in *Chorda filum*, seems to be a preparation for the air-bladders which in Fucaceæ are so common, and serve to float the plants. Even amongst these flat-tangles one species, the *Macrocystis pyrifera*, [vide §267, fig. A.] or everlasting bladder-thread, is furnished with vesicles, which appear essential to enable the weak yet lengthened divisions of its almost interminable frond to reach the surface of the water from the depths of the profound abysses in which it grows. This plant is said by sailors to have been found from 500 to 1500 feet in length. The present section, indeed, includes some of the longest and largest Algæ known. Lessonia fuscescens is described by M. Bory St. Vincent as being as thick as a man's thigh, and from twenty-five to thirty feet long. Laminaria bulbosa has a head so large, that a single plant is a load for a man. Laminaria digitata has a stipe about as thick as a walking-stick, and the frond divides at the summit into many belts, and, from its growing gregariously, tracts of this plant somewhat resemble submarine forests of palms. The Laminaria potatorum furnishes the aborigines of Australia with a portion of their instruments, vessels, and food; and Laminaria buccinalis [§ 267, B.] has a hollow stem, which the natives of the Cape of Good Hope convert into trumpets; and hence its common name of sea-trumpet, or horn-weed, [vide *Grev.*]

(275.) The *Durvillæa utilis* forms a very important and serviceable food to the poor in South America; and in this country, besides what are eaten by men and cattle, various Laminariæ are collected for kelp, along with the more usual kelpworts, which are chiefly contained in the following section.

(275.) FUCACEÆ. The *Tangs*, or sea-tangs, (Fucaceæ,) includ-

the plants under such circumstances, had enabled them to resist a degree of cold that would otherwise have destroyed them." Thus it is found that, not only the common sea-ware in its ordinary state, but even the refuse kelp, will form very valuable manure. "It appears," continues Dr. Greville, "from the communications made to the Highland Society, that the past success has been such, as to induce Lord Dundas to take a cargo of fifty tons of kelp to Yorkshire, for the sole purpose of agricultural experiments. It has been tried as a top-dressing, and singly, or in combination with other manures, on corn, pasture, potatoes, turnips, &c., with decided good effect. The committee appointed to collect the result of the experiments, are inclined to think that, for raising green crops, it would be better to compost it with other substances; that with good earth or moss, and a little vegetable or animal manure, a few tons of kelp would enable a farmer to extend his farm-dung over at least four times the usual quantity of land."

ing the black-wrack, or prickle-tang, (Fucus serratus) kelp-ware, or swine-tang, (Fucus vesiculosus), [vide § 51]; sea-whistles, or knob-tang, (Fucus nodosus), sea-oak, or knop-tang, (Halidrys); sea-thong, (Himanthalia), bladder-chain, (Cystoseira), with other allied genera, form, next to the *Floraceæ*, the most numerous type of the marine Algæ; and perhaps of all the most important and familiarly known.

Fucus, the normal genus, formerly included the whole of the known genera arranged in this section, as well as many that are now considered to belong to the Ulvaceæ and other types. Several of the genera, of which this is an example, were in truth rather *orders* than genera; and consequently, more accurate examination of the species, and intimate acquaintance with their habits and structure, has compelled their modern subdivision into many types; and although in this inquiry much has been lately done, much still remains to do. Of the fructification of the submarine flora, there is by far too little positively known to allow the characters of the types and sections to be generalized without various exceptions. On the whole, however, these are less both in number and importance, than the light which has so lately dawned on this field of study might have led many to expect.

(277.) The *Fucaceæ* are all marine plants, of an olive-brown or greenish colour, and of a very firm texture. In them the cellular structure is often much condensed, assuming a leathery, and sometimes a woody character; and so many fibres are developed (resembling slightly the Protonemata), along with the vesicles, that they tear with facility in a longitudinal direction, while most of the others rend irregularly: the base of the stipes forms a dense shield-like root, and the contrary extremity is often expanded into those foliaceous organs (pseudo-phylla) in which the cavities foreshadowed in the stems of Laminaria, and the leaves of Macrocystis become fully developed, and are named (*Pneumacysts*), or air-bladders. The fructification in these plants consists of small black, or very dark spores, with pellucid borders contained in distinct conceptacles collected into sori, which are either found indifferently on various parts of the frond, or, while some are barren, there are other peculiarly fertile branches.

(278.) "Fuci, with a few exceptions, do not inhabit very deep water, since, like other vegetables, they require light, and many of them also the occasional contact of air. A great part, therefore,

of the seeds they produce never germinate, for they are conveyed by currents, tides, and the reflux of the waves, into the bosom of the deep, and being never brought to shore again, they perish. It should hence be expected that nature would compensate for such destruction, by ordering the formation of spores in these plants to be very copious, and that such is the case one observation will prove. Mr. Turner was led to make a rough estimate of the number of seeds produced by a specimen of F. nodosus. "The specimen was small, being a little more than a foot long, and its fructifications were by no means numerous, yet on the most moderate computation the number of its seeds amounted 192,000."—*Drummond.* This plant sometimes grows to the length of six feet.

The gelatinous substance with which the spores of the Fuci and other sea-weeds are invested, seems to be a provision like the slime of the misletoe, and the threads of the Clutiæ, to fix them on the rocks against which they may be cast. And of the rapidity of their growth an interesting account has been placed on record by the same excellent naturalist, Mr. Neill, already so often referred to.

"A stone beacon was being erected on a low rock called the *Carr,* near the entrance of the Frith of Forth: This rock is about twenty feet broad and sixty feet long; and is only uncovered at the lowest ebb of spring-tides. It was at this time completely covered with the larger Algæ, especially Fucus esculentus and F. digitatus. By the necessary preparations for the beacon, these were all cleared off, and the rock reduced to a bare state by the beginning of November 1813, when it was obliged to be abandoned for the winter. The coating of sea-weed had at first been cut away by the workmen, the roots or bases afterwards trampled by their feet, and much of the surface of the rock had been chiseled. Upon returning to the Carr, in May 1814, in order to re-commence operations, it was matter of no slight surprise to find the surface again as completely invested with large sea-weeds as ever it was, although little more than six months had elapsed since the work had been left off, when, as already said, the rock had been cleared of weed. In particular, it was observed that many newly produced species of *F. esculentus,* measured *six feet* in length; and were already furnished with their fruit-bearing pinnæ. The common tangle, F. digitatus, was only about two feet long. It is to be observed, that the specimens here alluded to were taken from that part of the surface of the rock which had been dressed off with the pick or chisel the preceding autumn; they had therefore grown from the seed."

(279.) From the Himanthalia lorea (or sea-thong), Neill says, that a kind of sauce for fish somewhat resembling catsup, is made in the north of Scotland. The sea-thongs are said to be occa-

sionally found from ten to twenty feet in length; they make good kelp; but the F. vesiculosus is the more especial kelp-wort.

During the war, when barilla was subject to a very heavy duty, the kelp-manufacture was carried on to a great extent in the western islands and along the western shores of Scotland. At one time the kelp-shores in the island of North Uist were let for £7,000. a-year. It has been calculated that the quantity of kelp annually manufactured in the Hebrides only, exclusive of the mainland and of the Orkney and Shetland isles, amounted, at the period referred to, to about 6,000 tons a-year; and the total quantity made annually in Scotland and its adjacent isles, to about 20,000: which at some periods sold for £20. per ton; but the average price did not much exceed half that sum, viz. £10. 9*s.* 7*d.*, calculating the price it sold for during twenty-three years ending with 1822.—*Ed. Encycl.* Since the reduction of the barilla duties and the repeal of the duty on salt, the kelp trade has fallen off rapidly, and perhaps will soon be entirely extinct.

(280.) In the manufacture of kelp, "the plants are cut from the rocks, or collected from the rejectamenta of the sea, and dried in the open air. An excavation like a grave is made in the ground, and lined with large stones, and in this, which is named a kelp-kiln, the dried weeds are burned, the fire being kept up by constantly throwing them on the flames. The melted alkali, mixed with many impurities, accumulates in the bottom of the kiln, and when cold, forms a hard bluish mass, which is named *kelp*, and is a substance of great importance in bleaching and in the manufacture of soap and glass. Almost the entire rent of the island of Rathlin, on the northern coast of Ireland, was thus paid from the produce of its sea-weeds. The smoke rising from the kelp-kilns on a fine calm day has a very picturesque effect, and during the night they suggest the idea of so many altars employed in nocturnal sacrifice."—*Drummond.*

Notwithstanding the manifest advantage of reaping harvests from the ocean, and selling the crops grown on otherwise barren rocks, for £6000 or £10,000 per annum, which has been done by single individuals, so strong were the prejudices formerly entertained against kelp-burning, that when first the manufacture was introduced, violence was resorted to by the peasantry to extinguish the kilns, and the kelp-burners were obliged to be protected by

the officers of justice. Actions were instituted, and several trials took place, the malcontents pleading—

"That the suffocating smoke that issued from the kelp-kilns would sicken or kill every species of fish on the coast, or drive them into the seas far beyond the reach of the fishermen; blast the corn and grass on their farms; introduce diseases of various kinds! and smite with barrenness their sheep, horses, and cattle, and even their own families." The proceedings exist (as Dr. Greville was informed by Mr. Peterkin) in the records of the sheriff's court: "a striking instance, as he observes, of the prejudice, indolence, and superstition of the simple people of Orkney in those days."

(281.) So important was the kelp trade some years since, that "where the plants did not grow naturally, attempts were made, and not wholly without success, to cultivate them by covering the sandy bays with large stones. By this method, Mr. Neill states, that a crop of fuci has been obtained in about three years, the sea appearing to abound everywhere with the necessary seeds."—*Grev.* As this cultivation has been so far successful, it would be important to endeavour to naturalize some valuable exotic species to our shores; and as aquatic are much more widely diffused than land plants, the temperature of the medium in which they live being so much more equable, the project might be attempted with every probability of success: among others, it would be most desirable to naturalize Gracillaria tenax and Laminaria buccinalis.

(282.) One species of Gracillaria, the compressa, which is indigenous to our seas, appears, says Dr. Greville, little inferior to the Gracillaria lichenöides, so highly valued for food in Ceylon, and other parts of the east; for Mrs. Griffiths tried it as a pickle and preserve, and in both ways found it excellent." The other species mentioned, the Gracillaria tenax, would, if naturalized, be as invaluable to us as to the Chinese, being the basis of an excellent glue and varnish. "Though a small plant, the quantity annually imported at Canton from the provinces of Fokein and Tche-kiang, is stated by Mr. Turner to be about 27,000lbs. It is sold for sixpence or eight pence per pound, and is used for the purposes to which we apply glue and gum arabic. The Chinese employ it chiefly in the manufacture of lanterns, to strengthen or varnish the paper, and sometimes to thicken or give a gloss to silks or gauze." In addition to the above account, the substance of which, says Dr. Greville, I have extracted from Mr. Turner's work, Mr.

Neill remarks, that it "seems probable that this is the principal ingredient in the celebrated gummy matter called Chin-chou or Hai-tsai, in China and Japan. Windows, made merely of slips of bamboo, crossed diagonally, have frequently their lozenge-shaped interstices wholly filled with the transparent glue of Hai-tsai."

(283.) The simple structures of the Algæ appear not to enable them to elaborate many of those proximate principles which characterize the more complex plants. They chiefly consist of mucilage and albumen, none of them are in their natural condition poisonous, nor any even suspected of being deleterious. It must however be recollected that iodine, when separated from the mucilage with which it is naturally combined, and taken in a concentrated form, becomes a poison. Their gelatinous substance is extremely nutritious, and, were it not for the large quantity of salt with which it is blended, would probably be more used as food. From the experiments of Sir Humphry Davy, it appears that the Fuci yield one eighth of their weight of jelly. But so greatly do these plants "abound in salt, that from five ounces of the ashes may be procured two ounces and a half of fixed alkaline salts, or half their weight. This circumstance has led to an economical application of them for the purpose of salting cheese; for in Jura, and some other of the Hebrides, the inhabitants dry their cheeses without salt, and supply its place by covering them with the ashes of sea-ware."—*Hooker.*

(284.) In Gothland the Fucus vesiculosus is given as provender to hogs, whence its name *swine-tang;* cattle also will feed on it in winter; and it is a curious fact, that in some of the Scottish isles, as the deer do in other places, "the cattle go regularly down to the shore at ebb-tide, and feed on this and various other sea-weeds; and it is observed that they know their time exactly, even when far away from the sea, and not within view of it."—*Drummond.*

(285.) The Fucus serratus or saw-wrack, is chiefly employed as packing for crabs and lobsters; our fishermen use both it and the F. vesiculosus indiscriminately, but the Dutch reject the latter, on account of the large quantity of mucus the vesicles contain, which soon ferments and becomes putrid, and select the former, which, however, contains much less salt, and is far less esteemed for kelp. In Jersey the F. vesiculosus is collected and dried for winter fuel; and Linnæus says, that in Scania the poor people do the same.

(286.) These plants, especially the F. vesiculosus, are used medicinally to form cataplasms in scrofulous diseases, and Dr. Russel recommends the mucus in the vesicles as an excellent resolvent; and, by calcining the plant in the open air, he made a very black salt powder, which he called *Æthiops vegetabilis*, a medicine that was once much used as a resolvent, and recommended also as an excellent dentifrice to correct the scorbutic laxity of the gums."—*Lightfoot.*

"But the chief medicinal properties of the fuci is now known to depend upon a substance called iodine, which they afford. This element exists in various species, but it is chiefly procured from the F. vesiculosus. According to the observations of Davy, the Kelp-ware of France yields more iodine than that of the British shores, and according to Ecklon, the Laminaria buccinalis of the Cape of Good Hope contains more than any European Algæ. To the iodine they contain, the efficacy of sea-weeds in scrofula, and of burnt sponge in goitre, is to be attributed; and it is, as Dr. Greville observes, a very curious fact, that the stems of a sea-weed are sold in the shops and chewed by the inhabitants of South America, wherever goitre is prevalent, for the same purpose. This remedy is termed by them Palo Coto, (literally goitre-stick;) and, from fragments brought by Dr. Gillies, who gave Dr. Greville this information, the plant is decided to belong to the type *Laminaceæ*, and is probably a species of *Laminaria.*"

(287.) Iodine is certainly one of the most important of the remedial means added to the materia medica in modern times; subjecting, as it often does, some of the most intractable diseases to the dominion of art. [See § 51.]

(288.) The *Sargassum vulgare*, the tropic grape of sailors, and the Fucus natans of the older writers, is worthy attention, not only from its wandering habits, quitting as it does the submarine soil to which it probably in its early stages is attached, but also for the astounding profusion in which it so frequently is found. It only grows within forty degrees of latitude on either side of the equator, but currents often cast it on our coast. It is a remarkable circumstance in the history of this plant, that it is chiefly local in its position, even when detached, forming two great banks, one of which is usually crossed by vessels homeward-bound from Monte Video, or the Cape of Good Hope; and so constant are they in their places, that they assist the Spanish pilots to rectify their

longitude. It is probable that these banks were known to the Phœnicians, who, in thirty days' sail with an easterly wind, came into what they called the "Weedy Sea;" and to the present day, by the Spaniards and Portuguese, the chief tract is named *Mar de Zargasso.* It was the entering of such fields of fucus as these that struck so much terror into the minds of the first discoverers of America; for, sailing tardily through extensive meadows for days together, the sailors of Columbus superstitiously believed that the hindrance was designed by heaven to stay their adventurous course: hence they wildly urged their commander to proceed no further, declaring that through the bands thus woven by nature it would be presumptuous impiety to force a way.

(289.) Lichinaceæ. *Lichina* (or the *Lichen-flag*), usually included amongst the *Fucaceæ*, forms the transition from the *Fucinæ* to the *Lichens*, the succeeding order. It is, however, a plant so different from the true Fucaceæ, that it has been thought advisable by Greville (an opinion which circumstances fully bear out), to

Lichina confinis et pygmæa.

(*a*) Shoot of L. confinis. (*b*) L. pygmæa. (*c*) Ditto magnified.
(*d*) Conceptacle of ditto. (*e*) Transverse section of same. (*f*) Spores.
(*g*) Old conceptacle, collapsed and assuming a lichenoid appearance.

make of it a distinct type. Its characters will of course be the same as those of the single genus it at present contains.

(290.) The *Lichinaceæ* will be therefore known by their fibro-cartilaginous structure, their dingy green hue changing to black on exposure to the air, and their conceptacles furnished each with a pore. These conceptacles are filled by a colourless gelatinous mass of very fine filaments, among which pellucid oval or oblong

spores are disposed, in many radiating moniliform series. The conceptacles, when their contents have been discharged, collapse, and "at length resemble the old shields of a Lichen."

(291.) Thus the *Lichinaceæ* connect the *Fucales* by an easy transition to the following order, the *Lichenales*. The present name *Lichina*, as well as the older one Fucus *Lichenöides*, are evidences that the double similitude has been at all times perceived, and generally acknowledged. One species, indeed, the *Lichina confinis*, was formerly included by Acharius among his Lichens; its affinity with the fuci, and its situation on the confines of the two orders being indicated by its specific name.

(292.) These plants have, as Hooker observes, very much the habit, though not the structure of stereocaulon, amongst the Lichens, to which genus it was that Acharius referred them.

(293.) Two species only are known of the single genus which forms this type, and both are natives of Britain. They grow on rocks which are never permanently submerged; Lichina pygmæa on such as are much exposed to the air and almost dry at low water, Lichina confinis on others which are often left dry, and are only covered at high tides; so that it is a still less aquatic plant, and approaches still nearer to the habits of the Lichens.

(294.) The types *Lichinaceæ*, *Fucaceæ*, *Laminaceæ*, *Sporochnaceæ*, *Chordariaceæ*, and *Dictyotaceæ*, form collectively the section called, from Fucus, the most important genus, and the one in which they all were once included, the Fucinæ; and the Fucinæ, when associated with the Florinæ and Ulvinæ, constitute, as before observed [§ 261,] the order *Phycæ*, or rather Fucales; the distribution of which, when reduced to a tabular form, will be as follows:

Order.	Sections.	Types.
Fucales Phycæ	Fucinæ	Lichinaceæ. Fucaceæ. Laminaceæ. Sporochnaceæ. Chordariaceæ. Dictyotaceæ.
	Florinæ	Furcellaceæ. Spongiocarpaceæ. Floraceæ. Thaumasiaceæ. Gastrocarpaceæ. Caulerpaceæ.
	Ulvinæ	Lemaniaceæ. Ulvaceæ. Siphonaceæ.

GEOGRAPHICAL DISTRIBUTION OF THE FUCALES.

(295.) The geographical distribution of the Fucales is most extensive, some representative of the order being found in every latitude; the facility of transport and the more equable temperature of the medium in which they live may, in part, account for their omnipresence. The marine *Algæ*, those commonly known as *sea-weeds*, have however, as might be expected, a wider range than the *river-wracks*, or the *fresh-water ulvæ*.

(296.) Still, though the order is present by some of its species in all quarters of the globe, the stations of many of the types and genera are extremely confined; and, notwithstanding the ease of transit, some are absolutely local.

(297.) But a very short time since it was affirmed, on the then best and highest authority, that " plants which grow at the bottom of the sea are found in all regions, because the vicissitudes of heat and cold are never felt at such depths, the water being generally everywhere of the same temperature."

Yet even then it was known, that although some sea-plants are found " everywhere," " as well under the equator as under the poles," others are more local, especially such as prefer shallow waters; and these were supposed to be the only ones upon which climate had any influence. It had also been long remarked, that the heights of submarine hills are more productive than the deep gulfs and valleys of the ocean.

(298.) Such, until the present day, was nearly the sum of all that was known concerning the geographical distribution of the oceanic flora. Modern research has however given an unthought-of importance and an entirely new aspect to this branch of botany, which, as a science, may justly be claimed as the achievement of our age.

(299.) *Lamouroux*, *Bory St. Vincent*, and others, have already shewn that botanical regions exist, and that their boundaries may be traced, by peculiar vegetations in the sea as well as upon the land. Detailed accounts of their labours have been published in the Annales des Sciences Naturelles, (vol. vii. p. 60.), and in the botanical part of Duperry's Voyage round the World. Admirable sketches of their labours will also be found in " Brongniart's History of Fossil Vegetables," and in the Introduction to " Greville's

British Algæ." From these works the materials of the following condensed conspectus have been chiefly drawn.

(300.) Two contrary schemes may be pursued in the prosecution of phyto-geographical researches. Either the several zones may be examined as to the number and proportion of the types, genera, and species, existing or predominating in each, or the range of the several sections and other subordinate groups of the *Fucales*, or any other order, may be traced, and their respective stations noted. The first scheme which gives an account of the marine flora of any known and determined region is called vegetable statistics; the other, which affords an insight into the distribution of known and determined plants, is named vegetable topography. The former was neglected until the present day. The latter has long been more or less pursued, and records of habitats and stations kept in most systematic works with varying exactness.

Both these views should in turn be taken; for it is of manifest advantage to know, not only the vegetation of a certain district, but also all the zones and regions in which the same or similar plants are found.

(301.) The simplest division of the surface of the globe, and one that is quite sufficient for the first stage of the present enquiry, is into five zones, the two frigid, the two temperate, and the torrid: called the arctic, the antarctic, the north and south temperate, and the equatorial zones.

Geographers affirm that "every great zone presents a peculiar system of existence; and it is said that, after a space of twenty-four degrees of latitude, a nearly total change is observed in the species of organized beings, and that this change is mainly owing to the influence of temperature. Lamouroux remarks, that if this holds good, as we know it to do to a wonderful extent in phænogamous plants, it should also exert some corresponding force upon marine vegetation." And this it certainly does; for as Greville continues, "It is unquestionable that the *Algæ* are found on our own coasts in the greatest abundance during the summer months, and in unusual luxuriance in hot seasons. It is probable also, observes Lamouroux, that these plants may be acted on by the temperature of the water at greater or less depths, and that the species which grow at the bottom of the ocean may have some resemblance to those of the polar circle. On the shores of the British islands it is easy to perceive that some species, *Gelidium corneum*, *Phyllophora rubens*, and *Sphærococcus coronopifolius*, for example, become more plentiful and luxuriant as we travel from north to south; and, on the other hand, that *Ptilota plumosa*, *Rhodomela lycopodiöides*, *Rhodomenia sobolifera*, and several others, occur more frequently, and in a finer state, as we approach the north. *Odonthalia dentata* and *Rhodomenia cristata*, are confined

to the northern parts of Great Britain, while the *Cystoseiræ*, *Fucus tuberculatus*, *Haliseris polypodiöides*, *Rhodomenia jubata*, *R. Teedii*, *Microcladia glandulosa*, *Rhodomela pinastroides*, *Laurencia tenuissima*, *Iridæa reniformis*, and many others, are confined to the southern parts. Others again, such as the *Fuci* in general, the *Laminaceæ*, many *Delesseriæ*, some Nitophyllæ, Laurentiæ, Gastridia, and Chondri, possess too extended a range to be influenced by the change of temperature, between the northern boundary of Scotland and the south-western point of England." Researches and calculations on a much more ample scale have, however, shewn that "the great groups of Algæ do affect particular temperatures or zones of latitude, though some genera may be termed cosmopolite."

Thus the *Siphoneæ*, or at least the genus Codium and the Ulvaceæ, continues Greville, are scattered all over the world. Other types are, however, peculiar to the several great zones, and even many subordinate regions have each a characteristic vegetation.

(302.) Lamouroux states that the seas of the northern polar circle are the favorite habitats of immense *Laminaceæ;* these plants being much more abundant in the cold, though not absent from the temperate zones. The Fucaceæ are also found in vast numbers on the coasts of the same seas. A few of the Floraceæ are met with in similar situations, but much less frequently than in more temperate latitudes, where they are exuberant in the extreme. Lastly, that the *Ulvaceæ*, which are very widely spread, abound more in these parts than in any others. The circumpolar vegetation appears to be identical, or nearly so, both in the North Atlantic Ocean and in Behring's Straits.

(303.) In the South polar seas, on the shores of Van Diemen's land, and at the extreme point of the great continent of South America, the *Laminaceæ*, which are not met with in the tropical regions, re-appear in profusion. Here also are found several *Fuci*, shewing a further likeness in the vegetations of the arctic and the antarctic zones. *Durvillea* and *Lessonia*, formerly mentioned, [§ 274, 275], and the remarkable genus *Macrocystis*, all of which are *Laminaceæ*, seem to be peculiar to the Australian seas; the latter, however, exists only from the equator to the forty-fifth degree of south latitude: it is therefore characteristic rather of the southern hemisphere than of either of its zones.

(304.) In the temperate oceanic regions of Europe, the Fucaceæ, especially the *Fuci*, predominate, (one species, F. serratus, is entirely confined to Europe;) and where the Fuci become less common, some species of the allied genus Cystoseira take their place.

The latter are found between the fiftieth and twenty-fifth degree of latitude, while the former in general flourish only from the fifty-fifth to the forty-fourth degree, rarely being seen nearer to the equator than the thirty-sixth degree.

(305.) Bryopsis and the various species of Ulva, occur likewise in abundance, adding another feature to the characteristic vegetation of this zone; which, with the great predominance of the *Floraceæ* over the *Laminaceæ*, will sufficiently distinguish it from that of the Northern seas.

(306.) Of the vegetation of the south temperate zone, the information afforded is less precise. The *Floraceæ*, which, when abundant, are characteristic of the temperate regions, are less numerous in the southern than in the northern seas; "a fact that, Lamouroux thinks, may be accounted for from the inferior extent of the temperate zone in that hemisphere."

"In New Holland, remarkable alike for its vegetation and animal productions, a distinct group of Cystoseiræ predominates, as singular in the water as the Aphyllous Acaciæ are on the land. Their stems are compressed, often appearing to be jointed; the branches springing from the flat side and not from the angles, and are deflexed at their insertion, besides which, their vesicles are solitary and pedicellate."—*Grev.*

(307.) In the equatorial regions, new and very different plants are found, which come in hosts to characterize the equinoctial zone. Amongst the FUCACEÆ, *Sargassum*, or the tropic grape, commonly known as the sea-grass, or *gulf-weed*, supersedes the true Fuci. Immense masses of it, resembling islands, are constantly met with between the tropics, [§ 288] and examples rarely occur beyond the forty-second degree in either hemisphere.

(308.) The Red Sea is also full of Sargassa, whence, indeed, some persons think it has received its name. *Hypnea*, *Acanthophora*, Tamnophora, Amansia, and the delicate *Gelidium*, of which the eatable swallow's nests are made, are peculiar to this region. *Caulerpa*, also, is only found in the equatorial zone, or on the shores of the southern temperate region of New Holland.

(309.) Thus, although some types and genera are widely spread, there is found to be a vegetation peculiar to, and characteristic of, each great zone. Of these, the most notorious forms are easily recognisable. The *Laminariæ*, and the true *Fuci*, are distinctive of the cold and temperate zones: while Sargassum, Tamnophora, &c., are as rarely found excepting within the tropics. The first

named are consequently indicators of a cold, the last of a sultry clime.

(310.) Besides the general features characteristic of these great zones, which have been made out satisfactorily in their main points by Lamouroux, Bory St. Vincent has endeavoured to trace the differences of marine vegetation in subordinate oceanic regions, similar to the geographical regions of terrestrial plants.

For not only does "the polar atlantic basin to the fortieth degree of north latitude present a well marked vegetation, but the same may be said of the West Indian sea, including the Gulf of Mexico, of the eastern coast of South America, of the Indian ocean and its gulfs, and of the shores of New Holland and the neighbouring islands. The Mediterranean possesses a vegetation peculiar to itself, extending as far as the Black Sea; and, notwithstanding the geographical proximity of the port of Alexandria and the coasts of Syria to those of Suez and the Red Sea, the marine plants of the former, in regard to species, differ almost entirely from those of the latter. Bory St. Vincent characterizes each of his Mediterranean seas by a vegetation different from that of the Arctic, Atlantic, Antarctic, Indian and Pacific Oceans; and to a certain extent, (says Greville,) he is probably correct, as such seas are of less depth, often of a higher temperature, and more directly influenced by the countries which more or less surround them. The seas which he considers Mediterranean are, besides the Mediterranean commonly so called, the Baltic Sea, the Red Sea, the Persian Gulf, the Chinese Sea, the seas of Ochotsk and Behring, and the West Indian Sea, along with the Gulf of Mexico, denominated by him the Columbian Mediterranean."

(311.) The topographical range of the several groups of the *Fucales* has been already in part given when treating of the individual types and sections; little, therefore, on this point, now remains to be done, but to generalize the distribution of the large groups; the smaller types do not afford sufficient materials for generalization.

(312.) Lamouroux states it as his belief, that about 1600 species of Fucales are known, and have been collected and preserved in herbaria; he further calculates, though not on unexceptionable data, that between 5000 and 6000 exist in the various regions he points out. Our present knowledge of these plants must be, therefore, if his calculations approach the truth, very rudimentary and imperfect, for not many more than 500 species have as yet been fully described and absolutely determined to belong to the order. [§ 294.]

These have been associated to form three sections and fifteen types.

(313.) Greville observes, in his *Algologia*, when treating on this

subject, that "it is very clear and well known to the practical botanist, that marine plants are much influenced by the nature of the soil, not merely in regard to species, but in luxuriance and rapidity of development. A few yards is, in some instances, sufficient to create a change; and the space of three or four miles, a very striking one. Thus, calcareous rock favors the production of some species; sandstone and basalt that of others; and it would appear that soil has an effect even upon those algæ which grow parasitically upon larger species. But, sometimes, to all appearance independent of this cause, peculiar forms predominate in certain localities, both in regard to genera and species, which, as we approach their boundaries, gradually disappear, and often give place to others equally characteristic."

(314.) The very confined range of such plants gives the account of their distribution, a topographical, rather than a geographical, aspect. Others, however, though more widely spread, have been shewn to affect peculiar regions, and only to abound in certain latitudes; while others, again, are scattered over every part of the world.

(315.) "Amongst the *Siphonaceæ*, *Codium tomentosum* is found in the Atlantic, from the shores of England and Scotland to the Cape of Good Hope; in the Pacific, from Nootka Sound to the southern coast of New Holland. It abounds also in the Mediterranean, on the shores of France, Spain, and Africa, and is common in the Adriatic. It has, likewise, been recently brought from the coasts of Chili and Peru. This plant, however, is not a social one; it grows even in the same locality, in a solitary and scattered manner. The *Ulvaceæ*, on the contrary, are strictly social, and preserve this character in every part of the world. They appear, however, to attain to greatest perfection in the polar and temperate zones, although very fine Porphyræ have been brought from the Cape of Good Hope; and that they are capable of sustaining severe cold is proved by the fact, that fine specimens of Enteromorpha compressa, [§ 241], were picked up in high latitudes by some of the gentlemen who accompanied Captain Parry in his second voyage of discovery."—*Greville.*

(316.) Of the Lemaniaceæ, Furcellaceæ, Chordariaceæ, Lichinaceæ, Spongiocarpaceæ, Gastrocarpaceæ, Caulerpaceæ, and Thaumasiaceæ, several of which types consist of single genera, it may suffice to repeat that Lemania is the only fresh-water genus known; it inhabits mountain-torrents and impetuous streams in

the temperate regions both of Europe and North America. The Gastrocarpaceæ are indigenous to the temperate zone; Furcellaria, Chordaria, and Lichina, are also found upon our shores; and the Spongiocarpaceæ, both in the British seas and in those of Chili and New Holland. Caulerpa is confined to the southern hemisphere; and the extraordinary Thaumasia is a native of Ceylon.

It is evident, even from this brief recapitulation, that some of these plants have an extensive range, and that others, as far as we know, are extremely local; but, at present, too little information has been obtained to allow of further generalization.

(317.) The small groups being thus summarily disposed of, the four extensive types, *Floraceæ*, *Dictyotaceæ*, *Laminaceæ*, and *Fucaceæ*, are the only other ones remaining: and of their distribution, which is the most important, much more is known.

(318.) The *Dictyotaceæ* are rather tropical than European plants; for, although eight are found on the Scottish, and thirteen species on the English shores, they gradually and greatly increase, both in quantity and variety, in the seas nearer the equator.

(319.) The numerous genera and species of the very large type *Floraceæ*, are chiefly predominant in the north and south temperate zones. There are, however, various exceptions to this general rule. *Hypnea* and *Acanthophora* approach the type to the equatorial regions; and *Amansia* is exclusively found within the tropics.

(320.) "The *Laminaceæ*, among which are the giants of the marine flora, exhibit, in a broad view, a tolerably decided geographical distribution. The *Laminariæ* predominate from the fortieth to the sixty-fifth degree of latitude; while the Macrocystes seem, as far as we know, to exist from the equator to about the forty-fifth degree of south latitude."

(321.) The *Fucaceæ*, and particularly the *Fuci*, are the especial sea-weeds of the temperate zones; being found in those latitudes, both in the northern and southern hemispheres, although they are absent from the intermediate equatorial regions. The *Sargassum*, or tropic grape, which has been already mentioned as being so abundant between the twenty-fifth and thirty-sixth degree of north latitude, may seem a serious objection to the above statement; but the Sargassa, although produced within the tropics, grow, there is little doubt, at very considerable depths, so that the temperature of their habitats is less than that of the surface of the ocean in the equatorial zone.

"In the genus Sargassum there is also observed a small group as local, and almost as peculiar, as that just mentioned of the Cystoseiræ. It occurs in the seas of China and Japan, and consists of Sargassum fulvellum, microceratium, macrocarpum, sisymbriöides, Horneri, pallidum, and hemiphyllum, distinguished from the rest by their terminal fructification, a slender habit, small nerveless leaves, and often elongated vesicles."—*Grev.*

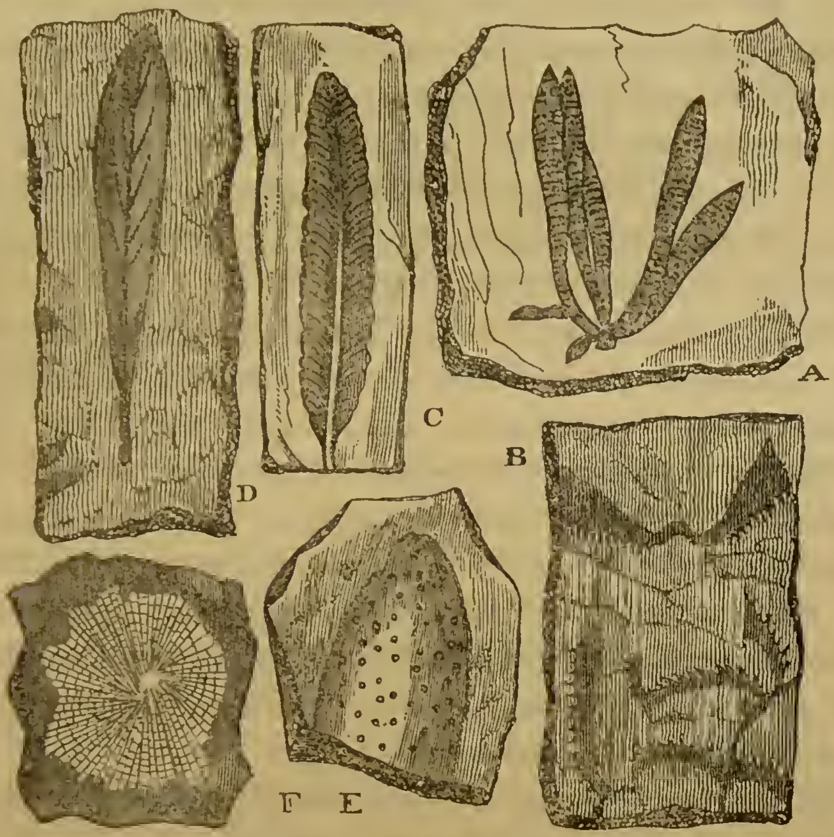
GEOLOGICAL DISTRIBUTION OF THE FUCALES.

(322.) The chief difference observable in the geographical distribution of the two preceding orders is, that the *Confervales* are peculiarly the inhabitants of cold and temperate regions, very few being found either in warm springs or in the equatorial zone; while the *Fucales* are the most abundant within the tropics, and extend from the equator to the poles. Does the geological distribution of these latter plants confirm the general views which have been taken of the geographical range of the present existing species in as striking a manner as it has been found to do with respect to the *Confervales?* [§219, et seq.] Do the facts presented by one of these twin-branches of natural science strengthen or refute the conclusions arrived at by the other?

(323.) As was the case with the *Confervales*, the whole of the fossil inarticulated algæ are included in a single group, or genus; of which, according to Brongniart, the following are further distinctive characters: "Continuous fronds, usually irregular, neither symmetrical, nor subcylindrical; sometimes simple, but more frequently branched, occasionally naked, but more often leafy; either membranous, entire, or more or less lobed, with no ribs, or imperfectly marked ones, the markings being irregular, and never anastomosing.

(324.) Although Brongniart associates all the fossil remains of the Fuci in a single genus, which he calls *Fucöides*, he has subdivided the group into several sections, or subgenera, which will probably hereafter be esteemed genera, and the present genus a fossil order. These subgenera are known by the termination *ites*, instead of *öides*, being suffixed to the name of the modern genus, to which they seem severally to be most nearly allied. Thus *Fucöides septentrionalis* is called *Sargassites; Fucöides strictus, Fucites; Fucöides tuberculosus, Laminarites;* and so on of the rest.

(325.) Among the fossil remains of ancient plants which, from their resemblance to the Fucales, have been named *Fucöides*, about six and thirty species have been discovered, and satisfactorily determined to belong to the present order.



A. Fucöides encœliöides. E. Ditto, apex of frond magnified. B. Fucöides serra. C. Fucöides Agardhianus. D. Fucöides Bertrandi. F. Ditto, portion magnified.

Of these, *four* species occur in the transition rocks, *seven* in the bituminous strata, *three* in the oolitic series, *eleven* in the chalk, and as many in the London clay formation. Thus, instead of being confined, like the Confervales, to the upper deposits of the secondary and tertiary groups, the Fucales are found in some of the most ancient strata of our globe.* Geographically ranging through every latitude; geologically spread through almost every epoch; unmindful of temperature now, they seem to have been able, in like manner formerly, to endure heats, which their weaker brethren, the Confervæ, could not withstand.

(326.) The fossil species found in the transition rocks are, 1st. the *F. antiquus*, discovered in the neighbourhood of Christiana.

* See Brongniart's History of Fossil Vegetables, page 412, et seq.; and Lindley and Hutton's Fossil Flora of Great Britain, Part iv.

2dly, *F. circinatus*, from the transition rocks at the foot of the Kinnekulle, in West Gothland. 3dly, *F. dentatus*. And, 4thly, *F. Serra*. Both these last named occur in the transition limestone of Canada.

(327.) No very striking resemblance has hitherto been traced between either of the two first-named fossils and any existing fuci. The former, however, Brongniart states to be more like a Sphærococcus than any other known genus. The *Fucöides dentatus* and *Serra*, [§ 325, B.], he observes, "although very different from any flags now actually in existence, appear to approach the nearest to *Amansia*, an exclusively tropical genus."

(328.) The seven found in the bituminous shale are *Fucöides septentrionalis*, *F. Nilsonianus*, *F. lycopodiöides*, *F. selaginöides*, *F. frumentarius*, *F. pectinatus*, and *F. digitatus*.

The first of the above, according to the opinion of Agardh, who has examined it in a favorable condition, is a *Sargassum*. The four next appear to belong to the genus *Caulerpa*. Of the affinities of the two last, it is difficult to form even a probable guess. Thus, of seven species, five belong, according to all appearances, to two genera, which are peculiarly characteristic of the marine vegetation of the equatorial zone.

(329.) In the vast series which separate the lower strata of the mountain limestone from the chalk, there are found scarcely any traces of sea-plants. The oolites, in their most comprehensive sense, contain but three, *F. Stockii*, *encœliöides*, [§ 325, A.], and *furcatus*; and their resemblances are chiefly to such living plants as are not characteristic of any particular regions.

(330.) The remains of fossil Fuci become more frequent in the strata which separate the Jura limestone from the chalk; and some remarkable species are found in these formations. *F. Targionii*, *æqualis*, *difformis*, and *intricatus*, have a common character, which shews them to belong to the same genus: a genus which approaches to *Chondria*, or *Sphærococcus* of Agardh; or rather to *Laurencia*, or *Gelidium* of Lamouroux; genera which, although not peculiar to any one zone, are much more frequent in the tropical and temperate than in the northern regions.

F. Brardii, *orbignianus*, *strictus*, and *tuberculosus*, which are found in the isle of Aix, are still more remark-worthy; for of these four, the two last present an organization which separates them very widely from all existing species; while the nearest

approach of the two former seems to be to *Caulerpa*, a genus, as already observed, that is peculiarly tropical. These plants, therefore, indicate a former submarine vegetation very different from what is now seen upon our coasts, and approaching rather to that of the equatorial region than of the polar zones.

(331.) Although the whole preceding ten species are found, in the strata called collectively the chalk formation, only one fossil flag has been discovered in the chalk itself; and that is the *F. Lyngbyanus*. This fossil also resembles *Caulerpa*.

(332.) If the fossil Fuci of the tertiary formations be now examined, a different result will be obtained. The most important of these are, the *Fucoides Sternbergii*, *Agardhianus* [§ 325, C.] *spathulatus*, *Lamourouxii*, *Bertrandi* [§ 325, D, F.] *obtusus*, *flabellaris*, *multifidus*, and several others. The two first named have a doubtful resemblance to *Sargassum* and *Caulerpa*; all the remaining ones to Algæ, which in the present day are indigenous to European seas, such as *Delesseria*, *Chondria*, and *Dictyota*. The resemblance, indeed, of these fossils is so strong with the three recent genera above-named, as to render it, for example, impossible to find any specific distinction between *Fucöides obtusus*, and *Chondria* (*Laurencia*) *obtusa* of our shores.

(333.) Thus the geological distribution of the *Fucales*, like that of the *Confervales*, fully corroborates the general views arrived at of their geographical range. Those fossils which occur in the upper or most recent strata of the earth, most nearly resemble the vegetation of our zone; while those, which are found in the more ancient formations, bear a greater similitude to the marine flora of the tropics; and lastly, the few remains which have been discovered in the transition series depart the farthest of all from the present oceanic vegetation of any region, some being wholly unlike every plant now known.

(334.) This gradual recession from tropical forms, as the series gradually recedes from the most ancient sedimentary deposits; and the progressive approach nearer and nearer to the present existing vegetation, and even to the aquatic plants of European countries, as the strata are of later and later formation, appears to indicate that there has been a gradual diminution of the temperature of the surface of our globe. But still as decided *Fuci*, and some of them bearing a resemblance to the tropical species of our own times, existed even in the transition epoch, and as the resemblances be-

come stronger and more numerous amongst those remains which abound in the bituminous shale, to say nothing of the doubtful Ulvinæ, [§ 220], it is not probable that the variation has been so extreme as many persons, on what would thus appear to be insufficient data, have been disposed to believe. The evidence, although decided as to the former higher range of temperature, does not, so far as it hitherto has gone, even warrant the suspicion that equatorial heats were ever felt in the frigid zones ; notwithstanding proofs are abundant that the temperature of the tropics once extended much further, than now, towards the poles.

(335.) In addition to the evidence offered by these plants of the former temperature of the globe, evidence which is fully borne out by the distribution of the Confervales, and which will receive further confirmation from the fossil remains of other natural groups, something may perhaps be learned of the physical condition of the earth, as respects the proportions which land and water held to each other in the remote eras now under consideration.

(336.) As no traces of land plants occur in any of those early strata in which the *Fucöides* are found; and more especially as not any remains of *fresh*-water *Ulvinæ* have been discovered, it is not unreasonable to suppose, that Fuci flourished before the waters were gathered together into one place, and before the dry land appeared. This will account for the non-existence, in this epoch, of the Confervales; so many of which are fresh-water plants: and whose chief duties are confined to streams and lakes, while the Fuci "occupy their business in great waters."

(337.) It likewise will not have escaped the attentive reader that *Confervites fasciculata* resembles Conferva ærea, a salt-water species, more closely than it does any other existing species; that Confervites(?) ægagropiloides is likened to the *oceanic*, not to the *moor*, balls; and, that the other fragments of Confervites, examined by Brongniart, are compared to the various genera of the type Ceramiaceæ, a group that is exclusively marine: nor is it, until arrived at the tertiary formations, that a fresh-water Confervites has been recognized in the solitary instance of C. Thoreæformis; which, be it observed, shews its chief affinity to be with *Thorea violacea*, one of the few known existing species of tropical Confervæ.

LICHENALES.

(338.) The *Lichens,** or *Aërial Flags*, the third and last order in this class, have been by some botanists considered as of inferior rank to all the other Algæ. But although they are often less in size, and although the simplest of the Time-stains are much more simple in their structure than the *Fucinæ*, they do not appear to yield to the simpler sections of the *Confervales;* and this more

A. Opegrapha minuta. (*a*) Group of plants. (*b, c, d, e*,) Sections of lirellæ, or lirelliform thalli. B. Opegrapha rugulosa. (*a, b, c*) Lirellæ detached. D. Graphis scripta. (*a*) Natural size. (*b*) Portion magnified. E. Stereocaulon salazianum. F. Ditto Apothecia, magnified. G. Ditto, Vertical section shewing the lamina proligera. H. Sphærophoron fragile. I. Ditto, magnified. J. Section of Apothecium. K. Bæomyces roseus. L. Apothecium magnified. M. Section of ditto. N. Gyrophora cylindrica. O, P, Q, R, S. Apothecia in the form of Cephalodia, with podetia. T. Gassicurtia coccinea. V, V, W. Ditto, magnified.

especially as in the Lichens and their allies, although the thallus is often less evolved, the spores are generally with more certainty developed. For as in the aquatic types, their moist localities favour a luxuriant growth of the organs of vegetation; so in the aerial order, the sun and air which tend, in arid places, to contract the thallus, favour the evolution of the fruit.

* Lichenes, Lichenales, or Lichenosæ, of various systematic writers.

(339.) The question of precedence, however, is not here attempted to be settled, nor is it indeed a point of paramount importance. In a strictly natural scheme, perhaps, the simplest sections of the aquatic and the aerial algæ, with the simplest sections of the three orders contained in the next class, Fungi should all be placed in proximity and treated of, as far as possible, together; for they all either set out from nearly similar simple forms, or else return to them; although the progress of their several developments takes place in very different courses: was rank, therefore, a matter of prime consideration, they should all be simultaneously described; but as such a plan could only lead to confusion, some gradation must be established, and that which is here adopted has several advantages to recommend it. For having, as it were, risen from the *Globulinaceæ* and *Siphonaceæ*, to the *Ceramiaceæ* and *Lichinaceæ* of the two preceding orders, the course proposed for pursuit will be, to descend in this from the moss-like* and flag-like Lichens,† through the mould-like lichens,‡ to the true moulds and mushrooms, or Fungi. In one order of which class, the lowest section of the *time-stains*, now associated with the other *Lichenales*, will be found even in the present day to be by most botanists included. While, on the other hand, *Lichina*, which forms the normal genus of our type Lichinaceæ, and which, being on the confines of the *Fucales*, is regarded as the transitional stage from the Fucinæ to the Lichens, has by some very able Algologists been referred to the lichens. Its aquatic habit and general characters, however, rather persuade to its retention among the Fucinæ. Still the links which it and the Myco-Lichenes, or Byssinæ, form, should be always kept in mind.

(340.) From these two points, therefore, the ascending and descending scales respectively commence. Here both shall be developed, for, after tracing in an upward course the several chief gradations of structure in the Lichens and their allies, as their evolution is supposed to be *regressive*, a return shall be made, in the practical demonstrations, from the confines of the *Fucinæ* to the *Fungi*.

(341.) This is, indeed, the course which a Lichenologist of great celebrity supposes that nature may have pursued in the formation

* *Bryo-Lichenes*, vel *Cetrarinæ*, (§ 363.)

† *Phyco-Lichenes*, vel *Verrucarinæ*, (§ 338, E, F, H, &c.)

‡ *Myco-Lichenes*, vel *Byssinæ*, (§ 338, N, O, P.)

of these plants; the Phycæ, or Fucales, being considered as the primogenitæ, and flourishing when the water covered the face of the earth. As the rocks and dry land appeared, these would give way to progressively more and more terrestrial series, such as the Lichinaceæ that are only occasionally submerged, and these would in their turn be followed by exclusively aerial species. Thus the Lichens are considered as a regressive group, in which the thallus becomes contracted; and Fungi a lower still, which, as they are parasitic on matter that has been once alive, must of necessity succeed the production of the substances on which they grow.

(342.) Analogous to the phycomater of the aquatic Algæ, a rudimental matrix precedes the development of their more characteristic organs in the aerial flags. Under certain circumstances this thallus remains permanently in its primordial state, without any further evolution taking place. Some Lichens are peculiarly prone to such abortions, which are known as their barren forms; while in others, especially such as grow in dark damp places, the thallus cannot easily be recognized as the matrix of any especial Lichen.

(343.) When the absence of fructification was esteemed a valid generic sign, many of these degenerate plants were grouped together, and from the leprous aspect which they give to the substances on which they grow, they were denominated *Lepræ*, or *Leprariæ*, [§ 390, fig. G, H, I. J.] In systematic catalogues several species will be found, named, and distinguished according to their colours, as the yellow, the green, and the tawney L. flava, chlorina, sulphurea, ochroleuca, &c. &c. It is, indeed, from the general scurvy appearance of these plants, that they are collectively denominated Lichens, (from λειχην.)

(344.) The thallus, which thus, as it were, constitutes the essence of a Lichen, and which is alone developed in the leprarious stage, assumes, in the superior grades, according to the varied force and predominance of the centripetal and centrifugal evolutions, very various forms. Sometimes it is extended into lines, when it is called *vertical*, [§ 364, A, B, C;] at others expanded, when it is called horizontal [§ 390, A.] The vertical thalli are either erect, as in Cladonia, [§ 380,] or pendent, as in Usnea [§ 364;] and either simple, or much divided, when they are called *Lorula*, [§ 338, fig. E, § 364, A, B.]

The horizontal thalli are very various likewise; but to their

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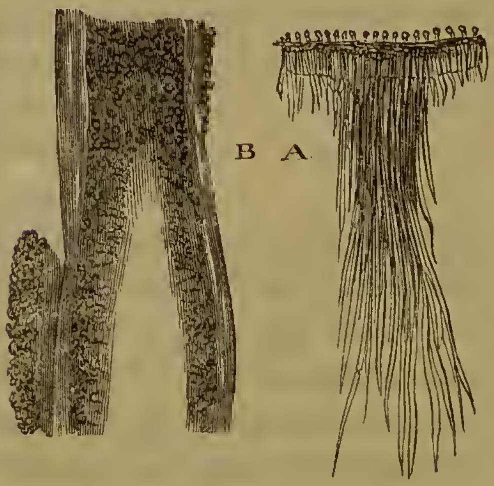
variations no especial names of note are given, further than that, according to their substance, they are said to be either foliaceous, subfoliaceous, [§ 364, C, D, E,] or when brittle, *crustaceous*, [§ 384.]

(345.) As in some Lichens, the thallus is alone developed; and in others it is predominantly evolved; so in those which verge towards the Fungi, the thallus becomes less evident, and in some is so obscure, as to be thought to be absent, *e. g.* the Opegraphas Verrucarias, &c. and as also in *Endocarpon athallum.*

(346.) The thallus in Lepraria, and the lower Lichens, as in the lower submerged algæ, consists of cellular structure, uncondensed, and not collected into any strata; but in the subsequent gradations, the thallus is found to be more or less evidently stratified, and the strata receive distinctive names; the under layer being



A. Epithallus and Mesothallus, Hypothallus wanting.

B. Epithallus, Mesothallus, and Hypothallus, all present, with fruit forming on the Epithallus.

called the hypothallus, and the upper the epithallus, while the intermediate portion is the mesothallus. These are the modern names given to the cortical and medullary substances of the older writers.

(347.) In some Lichens these several strata are all discrete, as in the *Parmelidæ;* while, in others, either may be absent or obscure; thus, in the *Usnidæ*, there is no hypothallus, while, in the *Byssaceæ*, the epithallus is wanting. Indeed, the whole section *Byssinæ* remains in what Fries terms the hypothalline state, [§ 390, G, H.] the cortical and medullary substances being blended together; the whole fabric is also either gelatinous or filamentous, with the reproductive organs irregularly scattered throughout. Some of the plants have occasionally been thought Algæ, and at other times Fungi.

(348.) The root-like holdfasts, by which Lichens are attached to trees, and fixed immoveably on rocks and stones, are named *fulcra*, or *ansulæ;* and the rootlets projected from the under surface of the thallus are called by some *fibrillæ*, but more properly *Rhizinæ*. [§ 346.] The tubercles with which the hypothallus is often thickly studded are called *cyphellæ*, and the hollows that occur in the epithallus are named *lacunæ*.

Occasionally the thallus is found to be double; when this structure occurs, the under portion is termed the *sub*-thallus, and the upper the *super*-thallus. It would appear that Fries sometimes confounds the *sub*-thallus in his definitions with the *hypo*-thallus. [§ 346.]

(349.) Rising from the epithallus there frequently are found minute arborescent productions, usually of a dark-green colour, called *pulvinuli;* they are abundant in *Parmelia glomulifera*, and are probably foreshadowings of more important parts to be immediately described. [See also the border of pulvinuli, in Gyrophora, § 338, fig. N.]

Parmleia Glomulifera.
(*a*) Entire plant.
(*b*) Portion magnified to shew the pulvinuli.

(350.) Such are the chief modifications of the thallus, as found in the various groups of Lichens, and such the names by which their several parts can be conveniently described. Other terms have been introduced, but they serve no further purpose than inconveniently to swell the catalogue of names.

(351.) When circumstances retard or prevent the development of the normal fructification, numerous bud-like organs are produced on various parts of the thallus, which are called *gonidia*, *conidia*, *gongyli*, &c. [§ 389, I, J.] These small powdery bodies, which spring like adventitious buds from any part of the surface

of the thallus, are the organs of reproduction in their simplest states. Sometimes they are very irregularly dispersed, but at others they are collected into groups, which are called *Soredia.* These are usually most abundant on plants growing in obscure places, where, from the absence of light, the normal fructification has become abortive; as in the leprarious forms of Lichens; and are less noticed when the spores are regularly evolved.

(352.) When the organs of reproduction become segregated and confined to especial parts of the thallus, such parts are called *Apothecia*, or *cases*, [§ 363, 367, &c.;] these cases are of various forms,* and according as they are absent, closed, or open, are the plants contained in this order distributed into various sections.

(353.) When the apothecia spring immediately from the thallus they are called *sessile*, [§ 338, fig. A, B, D, T, V, W.] if sunk with the substance of the thallus, *immersed* [§ 389, A, B, C, D,] but if they are raised by a prominence of the epithallus, they are called *stalked*, and the stalk is named the *podetium*, or, if very short, the *podicellum*, [§ 337, K, L, M, N, O, P.]

(354.) Each apothecium consists of the fructification itself; called, collectively, the *thalamium*, and the *excipulus*, or case that invests it; or, in other words, essentially of the *spores* in their *asci*, or *sporidia;* non-essentially of the *excipulus*, or partial receptacle, and medially of the *nucleus* or *lamina proligera*, to which the *asci* are attached.

(355.) When the excipulus is similar in its structure and appearance to the thallus, it is called an *Excipulus thallodes;* when dissimilar, an *Exc. proprius.*

The *excipulus* sometimes forms a bare margin round the *disk;* at others it rises so as nearly to enclose the *Thalamium.* In the one case the apothecia are said to be *shut*, [clausa, § 395,] in the other, to be *open*, [aperta, § 383.]

(356.) The opening of the *Apothecium* is called the *Ostiolum*, [§ 389, D;] and the open space, especially in *apothecia*, which are permanently patent, is called by some persons the disk; [§ 383, *e*,] occasionally a fine membrane, quickly perishing, covers the disk, which is called the veil, (velum.)

(357.) The lining of the Apothecium, often not distinguishable,

* The Apothecia are distinguished, according to their shapes, into Scutellæ, Patellulæ, Lirellæ, Pilidia, Orbillæ, Peltæ, Tricæ, Gyromata, Globuli, Mammulæ, Tuberculæ, Cistulæ, Cephalodia, Stromata, Sphærulæ, and Thalamia.

but sometimes, as in *Verrucaria*, of a cartilaginous consistence, is called the *perithecium.*

The *hypothecium*, when it separates and comes out from the *apotheceum*, bearing the sporidia within the *periithecium*, is called, according to its form, either *lamina proligera*, [§ 337, G,] or *nucleus proligerus*, [§ 395, *c*, *d*.]

(358.) The *spores* are roundish cellules contained within elongated cells, called *sporidia* or *asci*, [§ 383, *f*, 395, *c*;] which are themselves enclosed within the disks of the Apothecia, or seated upon them. Elongated floccose cellules are likewise often found intermingled with the sporidia, resembling the paraphyses of Fungi: organs hereafter to be described. They are probably only sporidia lengthened, their spores being abortive.

The fructification in general is sometimes called *thalamium;* but at others this term is restricted to those apothecia which contain a nucleus proligerus within them, as *Variolaria.*

(359.) Such is the common structure of the Lichens; and from this conspectus it will be seen that, in their general anatomy, they closely resemble, in many respects, the other Algæ; for the root, stem, and leaf, are still sublatent, or united in one common stock or thallus, the structure of which is purely cellular; and the organs of reproduction are either gonidia, or spores, or both.

But in the Lichens the thallus becomes stratified, prefiguring, as some assert, a like disposition of textures in a higher grade, (the Dicotyledons, and other Exogenæ, of authors;) while the Phycæ are said to foreshadow the ferns, and other endogenous plants: the organs of fructification also become more and more decidedly external.

(360.) This, among other reasons, has induced me to prefer the terms *Mycaffines*, *Termaffines*, and *Crescaffines*, to *Cellulosæ*, *Endogenæ*, and *Exogenæ*, as collective names. For Fries, in strictly following out the classification founded on the structure of the vegetative organs, has arranged the Mosses and Lichens amongst the *Exogenæ*, the Fuci along with the other *Endogenæ*, leaving the Fungi alone, of all the cellulares, to form the class that he calls *Syngenæ.*

(361.) The Lichens and their allies, although, like the Fucales, for the most part, formerly included in a single genus, are now distinguished into many, which are distributed into several types and sections, according to the progressive development of the organs just described, and their relative modifications. The sec-

tions depend upon the thallus being stratified or unstratified, and the apothecia open or closed. The unstratified Lichenales are termed, from *Byssus*, the normal genus, the *Byssinæ;* and of the stratified Lichens, those having open Apothecia, are denominated *Cetrarinæ;* those having closed Apothecia, *Verrucarinæ;* from *Cetraria* and *Verrucaria*, the two normal genera of the respective groups. The types are distinguished by subordinate characters, hereafter to be explained.

(362.) Until lately, the system of arrangement devised by Acharius almost universally prevailed; but the distinction and distribution of these plants have been so much improved and simplified by Fries, that since the publication of his "*Lichenographia Europea Reformata*," no doubt can be entertained that his labours will form the foundation of all modern schemes: therefore, his method, with some few slight modifications to render it compatible with the principles of these Outlines, will be adopted here.

CETRARINÆ.

(363.) The *Cetraria Islandica*, formerly known as the *Lichen Islandicus*, or *Iceland moss*, is a familiar example of the most extensive and economically important section of the Lichenales. This section contains two well-marked types, and at least five subtypes, associated by having their "Apothecia open and disciferous;" these characters are common to them all, whence they have been sometimes termed the Gymnocarpi, or naked-fruited Lichens; but *Cetrarinæ* is perhaps a preferable name, not only from its being a derivative of a well-known normal genus, but also from its etymological reference to the open shield-like fructification that pervades and characterises the entire section.

(364.) *Parmeliaceæ*. *Parmelia* (the Shield-edge,*) and *Usnea*, (the Lichen-hair, or Beard-moss,)† are the normal genera of two subtypes, called, from them, the Usnidæ (or *Usneæ*,) and *Parmelidæ* (or Parmelieæ,) which, together, form the type *Parmeliaceæ*, the first that occurs in the section *Cetrarinæ*.

* From πάρμη, a little shield or target, and εἰλέω, to surround.

† From the Arabic *âchneh*, the common name of all Lichens among the Arabians.

A. Usnea barbata. (*a*) Pendulous vertical thallus. (*b*) Open apothecia. B. Usnea barbata, var. articulata. (*a*) Barren ramifications. (*b*) Shields. C. Cetraria islandica. (*a*) subvertical thallus. (*b*) Apothecia. D. Cetraria juniperina. (*a*) Thallus. (*b*) Apothecium. E. Parmelia perforata. (*a*) Foliaceous thallus. (*b*) Open perforated apothecia. F. Parmelia parietina. Section of open apothecium.

(365.) The *Usnidæ* are distinguished by having an open disk, and being destitute of hypothallus. Their thalli, likewise, are vertical, either pendulous or erect, for in their evolution the centripetal force predominates.

The several varieties of Usnea, known commonly as Jupiter's beard (*barba Jovis,*) Tree-beard (*Arborum barba,*) &c. are, with some species of the two following genera, *Evernia* and *Ramalina*, the chief Lichens "which clothe so profusely the trees of too thick or decaying plantations; a fir wood on moorish ground is in particular much infested with them. The fir, the birch, the ash, the oak, the sloe, and the hawthorn are, when old, always hung with this hoary livery; but the elm, the sycamore, the lime, and the beech, wear it not, or very sparingly; so that when Gray speaks of the 'rude and moss-grown beech,' he applies to it a character by no means appropriate, for no tree is so little or so seldom either rude or moss-grown."—*Johnson.*

(366.) *Evernia*, a name admirably descriptive of the elegant branching thalli of the lichens to which it belongs, is derived from ἐν, excelling, and ἔρνος, a branch. E. *prunastri* is one of the most common British species, and, from its peculiar power of imbibing and retaining odours, it is in much request as an ingredient in sweet pots and perfumed cushions; and Evelyn says, that this "very moss of the oak, that is white, composes the choicest cypress powder, which is esteemed good for the head; but impostors familiarly vend other mosses under that name, as they do the fungi for the true agaric, (excellent for hemorrhages and fluxes,) to the great scandal of physic."

One species of this genus, viz. Evernia vulpina, is said to be poisonous, at least to foxes; whence its name. It is curious that a deleterious plant should be found in such a generally innocuous group.

(367.) Lightfoot says that one species of Ramalina, the R. scopulorum, or rock-branchlet, (Lichen calicaris of Linneus, and L. scopulorum of Dickson,) "will dye a red colour, and promises, in that intention, to rival the famous L. roccella, or argol, which is brought from the Canary Islands, and sometimes sold at the price of £80. sterling per ton. It was formerly used, instead of starch, in hairpowder." Johnston adds to this account that another species, the R. farinacea, affords a mucilage as good as that obtained from the Cetraria islandica.

(368.) *Roccella*, a corruption of the Portuguese *Roccha*, is a name given to several species of lichen, in allusion to the situations in which they are found, delighting to grow on otherwise barren seaward rocks, that thus produce a profitable harvest. Tournefort considers that one species at least (R. tinctoria) was known to the ancients, and that it was the especial lichen (λειχὴν) of Dioscorides, which was collected on the rocky islands of the Archipelago, from one of which it received the name of the "*purple of Amorgus*."

Both R. tinctoria and fuciformis are indigenous to Britain; they are found, though sparingly, on the maritime rocks of our southern coasts, especially in Portland Island; but in the Canary and Cape de Verd Islands, in Barbary, and the Levant, the former is common; and the latter, which "attains a much larger size, and is reported to vie in richness of colouring with the common orchill, is said to abound in the East Indies, especially on the shores of Sumatra;" and hence may probably become an important article of commerce.

Roccella tinctoria.

(*a*) Entire plant.

(*b*) Portion with fruit.

(*c*, *d*) Portions with apothecia magnified.

(*e*) Section of apothecium.

(*f*) Sporidia.

(369.) Under the name of *Archill*, or *Orchell*, (the Orcella of the Italians, and the Orseille of the French,) large quantities of this lichen are annually imported into this country, varying from ninety tons and upwards per annum. In times of scarcity it has fetched as much as £1000. per ton, but its usual price is not above a fourth part of that sum. The Canary orchell sells now at double the price of the Madeira, and the Barbary is the least esteemed of all: the former being sold at £290. per ton, while the second and third are only worth £140. and from £30. to £45. respectively.

(370.) The ancient mode of preparing orchell is said to have been lost, and rediscovered casually by a Florentine merchant, in the year 1300; and its preparation was long kept a secret by the Florentines and the Dutch. The former, to lead other manufacturers astray, called it *tincture of turnsole*, pretending that it was extracted from the Heliotropium, or turnsole; and by the latter it was made into a paste, which they called *lacmus*, or *litmus*. At present it is well known that the process consists in cleaning, drying, and powdering the plant, which, when mixed with half its weight of pearlash, is moistened with human urine, and then allowed to ferment. The fermentation is kept up for some time by successive additions of urine, until the colour of the materials

changes to a purplish-red, and subsequently to a violet or blue. The principal British manufactories are in London and Liverpool. The colour of orchil is extremely fugitive, and it affords one of the most delicate chemical tests for the presence of an acid. The vapour of sulphuric acid has been thus detected, as pervading to some extent the atmosphere of London.

(371.) *Cetraria* [§ 364, fig. C, D,] from *cetra*, a Moorish buckler, is the modern systematic name of the genus that contains the Lichen islandicus, or Iceland moss, which in commerce is often mixed with another species, the C. odontella. Several species are natives of our alpine woods and mountainous heaths. Sir James E. Smith found the Islandica on the Pentland hills, on Ben Lomond, and in various parts of Scotland. It grows, however, much more freely in the more northern parts of Europe; and Dr. Holland states that it abounds on the lava on the western coast of Iceland, where the whole plant is much more luxuriant than with us.

The bitter and purgative principles of this Cetraria may be separated by steeping it in cold water, which is done by the Icelanders and other northern nations, with whom it forms an important article of food; these poor people with gratitude confessing that out of the rock the Almighty gives them food; commanding that the very stones should furnish bread.

(372.) Immense quantities of this lichen are annually collected in Iceland for exportation, as well as for home consumption. After steeping in cold water, drying, and powdering, the Icelanders make it into cakes, or eat it boiled in milk; and Henderson, in his Tour through Lapland, says that a porridge made of this lichen flour is to a foreigner not only the most wholesome, but also the most palatable, of all the articles of Icelandic diet.

The esculent qualities of the Iceland moss have been long recognised in many parts of the continent of Europe; and it has lately been recommended by authority to use it, either alone or mixed with flour, in the composition of bread in times of scarcity. The Saxon government have published a report on this subject, which is full of interesting information to the inhabitants of those mountainous districts where the plant abounds. In this report we are informed that 6 lbs. and 22 loths of lichen meal, boiled with 14 times its weight of water, and baked in this state with 59½ lbs. of flour, produced 111½ lbs. of good household bread. Without this

addition, the flour would not have produced more than $78\frac{3}{4}$ lbs. of bread; consequently, this addition of 6 lbs. and 22 loths of lichen-meal has occasioned an increase of $32\frac{3}{4}$ lbs. of good bread. It is known that 3 lbs. of flour yield 4 lbs. of household bread; 1 lb. of lichen-meal added, in the form of paste, gives an addition of nearly 6 lbs., and therefore is equivalent in this view to about $3\frac{3}{4}$ lbs. of flour, because it affords above $3\frac{1}{2}$ times more bread. But, notwithstanding this important fact, at present nearly all the Iceland moss collected in Germany is sent, through Hamburgh, to England, where it is used in brewing and in the composition of ship-biscuit; as it is said biscuit which contains it is not attacked by worms, and suffers little from the action of sea-water. This lichen, when deprived of its bitter principle, forms an excellent soup, and, when coagulated, a good jelly; and it has been recommended in this prepared state as an excellent substitute for sago, salop, and even for chocolate.—*Ed. Phil. Journ.* iii. 414.

(373.) Of the *Parmelidæ*, the second subtype of the *Parmeliaceæ*, the genera *Peltigera* (the shield-bearer, *Sticta*, and *Parmelia*, [§ 364, E, F,] are the most notable examples. This subtype is distinguished from its congener, the Usnidæ, by having the thallus horizontal, the centrifugal evolution predominating, and the hypothallus being present; the disk likewise at first is closed, although it subsequently opens.

(374.) The two most noted species of the genus Peltigera (or target-bearer), are the *canina* and *aphthosa*, both handsome plants, especially the latter, which, from its aphthoid appearance, is much esteemed by the Swedish peasants, who boil it in milk as a remedy for the thrush; but, since the doctrine of signatures has fallen into disrepute, it maintains its credit, like the canina, only among the ignorant. P. canina owes its name to a former belief of its efficacy in the cure of canine madness. "The powder of the dried plant was celebrated by Dr. Mead as a certain cure, and Dillenius gives the history and receipt at full."—*Johnson.*

(375.) Of *Parmelia* [§ 349 and 364,] a very extensive genus, including, according to Fries, eight subgenera, the bare mention of which must now suffice, the yellow moss, and the cudbear, are the most familiar and important examples. The first-named species, P. parietina, clothes profusely the boughs of the hawthorn, and many other trees, in autumn, with a tunic of a bright-yellow hue. Lightfoot says, "It is affirmed to dye a good yellow, or orange

colour, if mixed with alum." P. tartarea has long been used, both by the Welsh and Scotch, as a dye for wool; but it was first extensively employed by Dr. Cuthbert Gordon, who took out a patent for his process, and whose Christian name, Cuthbert, or Cuddy, corrupted into *cudbear*, has been given to the dye-stuff. About 130 tons of cudbear are annually exported from Sweden; it sells in the port of London at about £20. per ton. A good deal likewise is collected from our own rocks. Hooker says, that in the neighbourhood of Fort Augustus a person could earn, in 1807, 14*s.* per week at this work, the material selling at 3*s.* 4*d.* the stone of 22 lbs.; and Johnston adds, that in the highland districts many an industrious peasant gets a living by scraping this lichen off the rocks with an iron hoop, and sending it to Glasgow market. Like most other lichens, it is a perennial plant, but of such tardy growth, that the crops can scarcely be collected with advantage oftener than once in five years.

(376.) Another species, the P. parella (*Lecanora parella,*) is said, by the same writer, to afford the finest litmus; and the P. candelaria has so been named from its being employed by the Swedes to stain the candles they use in their religious ceremonies. Several other species likewise afford dye-stuffs, especially the P. omphalodes, which Pennant says formed, in 1772, an important article of commerce from the west of Scotland, being sold at 1*s.* or 1*s.* 4*d.* per stone. This lichen, which was formerly much used by the peasants in our provinces to dye their woollen cloths of a dull-brown colour, and, when steeped in urine, was employed by the highlanders for similar purposes, and known under the name of Crostil, or Crostal, seems to deserve more attention as a source of colouring matter than it has hitherto received. It is said that it imparts easily a tawny-red hue to a solution of volatile alkali, and that this infusion affords one of the most indestructible of all colours. Indeed, Dr. Walker declares, that "the colour remains after the substance that extracted it is gone; it is not the least impaired by long exposure to the air; nor can it be either destroyed or changed by acids, alkalies, or alcohol; a most singular property, as there is no red dye in use that remains unaltered by these powerful agents."

(377.) Of the genera *Sticta*, *Dirina*, and *Gyalecta*, little need now be said, further than that the first-named genus affords some of the most handsome lichens known; and one species, the S. pulmonacea, or lung-wort, has been much praised as an excellent medicine in pulmonary complaints, if indeed it can be considered praise

to say that its curative effects in consumption are equal to those of the far-famed Cetraria islandica. With these plants the subtype *Parmelidæ* concludes, a subtype by which, with the Usnidæ, already noticed, the type *Parmeliaceæ* is formed.

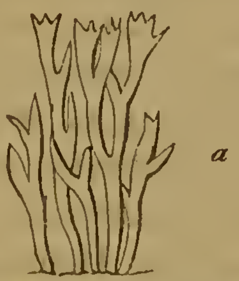
However much these plants may differ in various subordinate particulars, they all agree in having roundish persistent disks, bordered by thalloid excipuli; and this structure therefore becomes the distinguishing characteristic of the type.

(378.) *Graphidaceæ*, the second type of the *Cetrarinæ*, to which *Graphis* (the *scripture-wort*, § 338, D), gives name, includes three subtypes, the *Lecididæ*, *Graphidæ*, and *Calicidæ*; the second, and perhaps even the two last, of which are but artificial divisions of the one first named: still, however this may be, it is as well they should be retained, as the distinctions are practically convenient.

(379.) The different species of Lecideæ are, especially in mountain districts, familiar to almost every eye, and are interesting from the indications they afford of the nature of the soil on which they grow, some being absolutely saxicolous, while others are found on other soils. Of these, perhaps, the L. geographica is one of the most elegant, if any selection can be made from a group where all are exquisitely beautiful, notwithstanding their minuteness veils their beauties from almost every eye. The corticolous Lecideæ are likewise worthy attention, from the diagnostic signs which they afford of several of the officinal barks upon which they respectively abound, as the aurigera on the brown, the tuberculosa on the yellow, and the conspersa on the red bark.

(380.) But the most interesting and important illustration of this subtype will be found in the well-known reindeer moss, the *Cladonia* (or *Cenomyce*) *rangiferina*, of which, although indige-

Cenomyce coccifera.



Cenomyce uncialis.

nous with us, the specimens that are common on our moors are very insignificant to those which are furnished by more northern climes. In the arctic regions, and especially in Lapland, it grows in the utmost profusion, and overspreads, as with a coverlid of snow,

plains hundreds of miles in extent. These, which to a stranger, or a traveller arrived from what prejudice would call a happier land, might seem dry and barren wastes, are the very fertile fields of the Laplanders, "Hi sunt Lapponum agri, hæc prata eorum fertilissima, adeo ut felicem se prædicet possessor provinciæ talis sterilissimæ, atque lichene obsitæ;" for, when the cold of winter has withered up every sort of herbage, and its storms have driven man and beast to the shelter of the valleys and the woods, this moss becomes the principal aliment of the herds of reindeer, in which consists all the wealth, and on which depends the very existence of the natives. "Thus things," says Lightfoot, "which are often deemed the most insignificant and contemptible by ignorant men, are, by the good providence of God, made the means of the greatest blessings to his creatures." According to Linneus, the Laplanders likewise collect the C. rangiferina with rakes in the rainy season, when it is flexible, and separates readily from the ground, lay it up in heaps, and give it when required to their cows, for which it affords excellent fodder. "At the limits of the arctic circle there is a brood of cows so small, as not to be larger than sucking calves. Their milk is almost all cream; sweet and delicious, and so thick that it draws out in strings. This goodness of milk arises from the plant on which the cows feed, viz. the Lich. rangiferina."—*Bucke's Harmonies of Nature*, ii. 149.

(381.) *Cenomyce rangiferina* may even be directly applied to the use of man. Tempted by the beauty of its appearance, Dr. Clarke and his companions in travel, tasted it. "To our surprise (he says), we found that we might eat of it with as much ease as of the heart of a fine lettuce. It tasted like wheat-bran; but, after swallowing it, there remained in the throat and upon the palate a gentle heat, or sense of burning, as if a small quantity of pepper had been mixed with the lichen. We had no doubt that if we could have procured oil and vinegar, it would have afforded a grateful salad. Cooling and juicy as it was to the palate, it nevertheless warmed the stomach when swallowed, and cannot fail of proving a gratifying article of food to man or beast during the dry winters of the frigid zone. Yet neither Laplanders nor Swedes eat of this lichen. Finding it to be so palatable, we persuaded our servants to taste it; and, after experiencing the same effects from it that we had done, they began to eat it voluntarily. Upon this we asked the peasants why they neglected to make use of so important an article of food, in a land so sterile as that which we were now travers-

ing. They told us that, when Gustavus III. succeeded to the throne, an edict was published and sent all over Sweden, recommending the use of this lichen to the peasants in time of dearth; and they were advised to boil it in milk. Now and then, they said, a few of the indigent poor had made it serve as a substitute for bread; but being unaccustomed to such food, they generally neglected it."—*Clarke's Travels,* Part iii. § 1, p. 566. "Nor is this to be wondered at, for Clarke had tried it only in a solid and unprepared state, and was incompetent therefore to say what sort of food it might really make, which, from the account of Dillenius, is, in fact, indifferent enough. "Aquâ quidem decoctus hic muscus nullam gelatinam præbet, nec substantia ejus imminuitur, siccatus tamen fragilior, quam ante, evadit. Decoctum inspissatum extracti acerbi et austeri parcam quantitatem largitur."—*Johnson.*

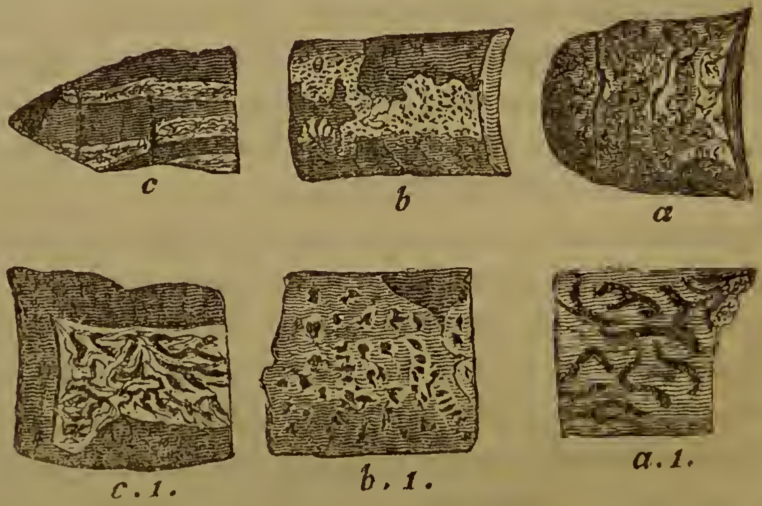
(382.) *Lecidea,* and those more immediately normal genera, such as *Cladonia, Stereocaulon,* [§ 338, fig. E, F, G.], *Bæomyces,* [§ 338, fig. K, L, M.], and *Biatora,* in which the persistent disks are roundish, and the proper excipuli at first are open, and subsequently half enclose the thalamia in cephaloid apothecia, form the subtype *Lecididæ.* From these, the *Graphidæ,* in which, although the excipuli when present are proper, the disks are irregular, and often lirelliform, and the *Calicidæ,* in which the proper excipuli enclose orbicular or subrotund disks destitute of sporidia, are seceding or degenerate groups; for in the *Graphidæ,* although the excipuli when present are proper, the disks are irregular, (often lirelliform): and in the *Calicidæ,* although the proper excipuli enclose orbicular or subrotund disks, the sporidia are wanting.

(383.) Of the subtype *Graphidæ, Umbilicaria,* the naveling and *Opegrapha,* the *chink-writ,* are well-known examples, [§ 384.] Some species of the first-named genus, (including, according to Fries, the Gyrophoræ [§ 338, N, O, P, Q, R, S.] of other authors), furnish the rock-tripe of the Canadian hunters, upon which they often for a time subsist; and these plants have lately become peculiarly interesting to us, from their affording opportune and very welcome food to our adventurous countrymen, in their travels towards the Pole.

One species of *Graphis,* the normal genus, viz. *G. interrupta,* is said by Fee to be found only on the bark of *Cinchona lancifera.* Hence plants of this kind become practically very useless guides, enabling the true officinal bark to be distinguished from other substances with which in commerce they are often mixed. Several

of the Opegraphas, and other lichens, are, in a similar manner, diagnostic of various barks; and not only do they indicate the species, but many, as *Opegrapha rhizicola* [Fee xiii. 2], *Fissurina*, &c., distinguish those specimens which have, either from age or decomposition, become unfit, from those which are fit, for medicinal purposes.

(384.) Until the publication of Fee's Memoir on the cryptogamic epiphytes of the officinal barks, the study of the opegraphas and their allies seemed to be one rather of speculative amusement than of practical utility. But now the case is wholly changed, since these graphic plants, these living letters written by nature's hand, are shewn to constitute inscriptions legible by men. Always curious indeed, and admirable, even to the least tutored eye, did the examination of these mimic characters appear; and as fancy traced the likeness to various oriental signs, so were these little plants called scripture-worts, some Hebrew (Opegrapha hebraica), some Chinese (Arthonia sinensigrapha), and so forth. But, like the hieroglyphics of the Egyptian fanes, their meaning was buried in obscurity, and so little guessed at, that it often was doubted whether they had any secrets to reveal. They were sources of wonder rather than of wisdom, until the Young and the Champollion of the vegetable world arose, and by means of a natural Rosetta-stone



(*a*) Opegrapha Condaminea. (*a* 1) Ditto, magnified. (*b*) Enterographa Quassiæcola. (*b* 1) Ditto, magnified. (*c*) Sarcographa cascarillæ. (*c* 1) Ditto, magnified.

deciphered these hitherto unknown manuscripts, and taught us to peruse this part of the sacred Scriptures of creation.

(385.) *Calicium* and *Coniocybe*, verging towards the fungi, form the subtype *Calicidæ*, the chief distinctive characters of which are their orbicular or roundish disks, encompassed by pro-

per excipuli, (which, however, are sometimes obscure or wanting,) and the degenerate state of the sporidia.

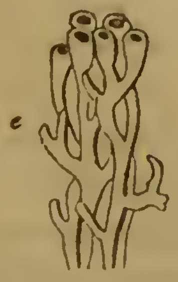
These lichens are found to flourish upon putrid wood and other decaying vegetable substances, as well as upon old trees, the earth, and stones; and some of them were formerly included by Linnæus among his Mucores. Persoon likewise enumerates them in his Synopsis Fungorum amongst the fungi; and as Fee observes, were it not for their lichenoid crust, they might well be associated with the mucedines, which they resemble in general appearance, and almost in their structure. Acharius, also, who carefully investigated the genus *Calicium*, and published the result of his researches in a monograph, determined it to be a Lichen, and Fries, and most modern authors defer, and with justice, to their combined authority. Hence, among the Calicia will be found the late *Trichia*, or *Mucor Lichenöides*; and to *Coniocybe* are referred the old *Mucor furfuraceus*, *fulvus*, *sulphureus*, and so forth.

(386.) In the three subtypes Calicidæ, Graphidæ, and Lecididæ, the excipuli, when present, are always proper, and hence the type *Graphidaceæ* or *Opegraphaceæ* is formed; a type which is thus well distinguished from the *Parmeliaceæ*, in which the excipuli are always present and always thalloid.

(387.) These two types, though differing in their thallode and proper exciples, agree in having their apothecia open and disciferous, and thus, by their gymnocarpous structure, they collectively form the section *Cetrarinæ*, as already stated.

VERRUCARINÆ.

(388.) *Pertusariaceæ*. The Coral moss, Isidium (or Sphærophoron), corallinum, and other species of Sphærophora, as the coralloides, or coral atlas-work, are beautiful illustrations of a small subtype, in which the thallus is developed vertically, the exciputi are purely thallode, closed, and having a lacerated dehiscence. From the normal genus the group is denominated the *Sphærophoridæ*; and in beauty they yield to none even in an order where, as already observed, elegance is the common lot of all. They are easily distinguished by their peculiar coralline form and suffruticose habit, as well as by the characters above described. None of them have as yet been employed to any extent for economical purposes; but Westring has found the *Isidium corallinum* to be "extremely rich in colouring matter,



Isidium corallinum.

and he recommends it to the particular attention of those who practice, and who wish to improve, the art of dyeing."

(389.) In the allied subtype, containing the genera *Endocarpon*, *Chiodecton*, *Pertusaria*, and others, which, from the first-named genus, is called the *Endocarpidæ*, the thallus s horizontal, and in all but *Endocarpon* it is crustaceous; the closed excipulus is thalloid, and is pierced by an ostiolum.

(390.) *Endocarpon* has been well named with reference to the

A. Endocarpon miniatum. B. Portion of thallus. C. Section of ditto. D. Ditto, magnified, to shew the immersed apothecia and ostioles. E. Hypochnus rubro-cinctus. F. Portion removed from the bark. G, H. Lepraria flava. I, J. Portions removed from the wood. K. Monilia.

imbedding of its apothecia in the thallus; a character that hereafter will be seen (through Riccia) to connect the Lichens with the Hepaticæ, which were once, like them, considered Algæ. These plants are sessile on rocks, stones, &c., and one species is even parasitic upon an ally, *Pertusaria omphalodes*.

(391.) *Chiodecton*, the snow-wart, so called from χιων and δεκτικος, the tubercles being seated on a thallus, white, like drifted snow, promises to become an important diagnostic sign of the bark of the Cinchona cordifolia, to which one species (C. effusum?) is said by Fee to be peculiar.

(392.) *Pertusaria,* the porelet, (from pertusus, perforated,) and its ally, *Thelotrema,* (from θηλη, a nipple, and τρῆμα, a hole,) are further illustrations of this subtype. They are chiefly interesting as affording two further distinctive signs of officinal barks, the latter, (T. urceolare) of the Cinchona oblongifolia, or red bark, the former in that variety of *P. communis* called amara, (*Variolaria amara* of some writers,) of the inferior value of the barks on which it is found. According to Fee, this lichen chiefly grows on the very old bark of Cinchona cordifolia, and denotes by its presence a bad quality. *Variolaria amara* is itself, as its name imports, extremely bitter; and as it is very abundant in many districts, it ought, as the same Lichenologist observes, to have its medicinal properties ascertained, for, probably, it might be employed with advantage in certain diseases; it readily imparts its intense bitterness both to water and spirit.

(393.) These two tribes, or subtypes, the *Sphærophoridæ* and *Endocarpidæ,* although differing in the minor characters of their vertical and horizontal thalli, and in their regular and irregular dehiscence, still agree in the more general characteristic of having in common thallöid excipuli, and hence they form together the type *Pertusariaceæ,* which is thus distinguished from that which follows, viz. the Verrucariaceæ, in which the excipuli are proper.

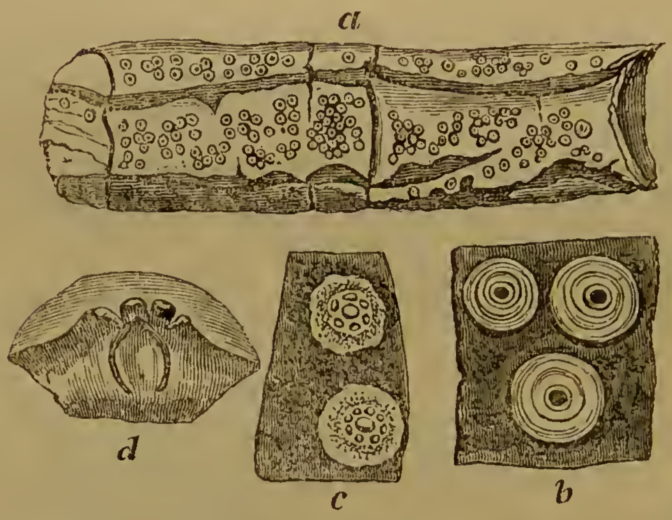
(394.) *Verrucariaceæ. Verrucaria,* the *wart-let* (from verruca, a wart,) and *Gassicurtia,* [§ 338, T, V, W,] an exotic genus, said by Fee to be found exclusively on the yellow bark, (Quinquina jaune royal,) and to which therefore, in commerce, it is an admirable guide, will serve as examples of the first type of the first section of this order; a section which, from Verrucaria, receives the common name of Verrucarinæ, as Verrucaria has been so called from its resemblance to a wart.

(395.) In these plants and their immediate allies the apothecia, are closed and nucleiferous; hence the section has been called Angiocarpous, but consistency compels a preference of denomination from its normal genus Verruca, and hence it is above described as the section VERRUCARINÆ.

(396.) *Verrucaria* and its allies, forming the small subtype *Verrucaridæ,* chiefly differ from the Endocarpidæ, to which, with the exception of their proper excipuli, they are very similar, by the non-dehiscence of the apothecia, and the nucleus being deli-

quescent. The species, both European and exotic, are very numerous, and a great many are epiphytic on the officinal barks, but in this respect they are such cosmopolites that they do not afford any very decided differential signs, or at least the distinctions have not as yet been sufficiently made out. One species of *Ascidium*, which grows commonly on several of the officinal barks, may be given as an illustration.

Ascidium Cinchonarum.



(*a*) Group of plants natural size. (*b*) Portion magnified. (*c*) Ditto after the lapse of the perithecium, shewing the sporidia in the thalamium. (*d*) An apothecium separate and magnified; section to shew the nucleus proligerus.

But although these and many other epiphytic lichens do not each indicate specific plants, their general presence or absence will often assist in discriminating otherwise nearly similar vegetable productions. For example, it has been already mentioned [§ 365,] that the Beech, though not absolutely destitute of lichens, is far less licheniferous than the oak, the ash, the hawthorn, or the fir; and in like manner it has been found that the spurious angustura bark, which is obtained from a species of *Brucea (B. antidysenterica,)* and which contains a poisonous principle analogous in its properties to *Strychnia*, bears very few lichens of any kind; while the true *Cusparia febrifuga*, which is an admirable tonic, bears them in abundance.

(397.) Limboria (the borderlet,) Pyrenothea (the nutlet,) and several other seceding genera, which verge towards the Calicidæ of the Cetrarinæ, and the Lepraraceæ of the Byssinæ, constitute the subtype Limboridæ, that concludes this section. They differ

from the Verrucaridæ in their varied and irregular dehiscence, and the carbonaceous character of their exciples; although both subtypes agree in having proper excipuli and crustaceous thalli; and hence they, together, form the type *Verrucariaceæ*, with which the section Verrucarinæ closes.

(398.) The lower rank of these Lichens is well shewn from several, as the *Pyrenothea incrustans*, *vermicellifera*, &c. having been formerly considered Leprarias and Lepranthas.

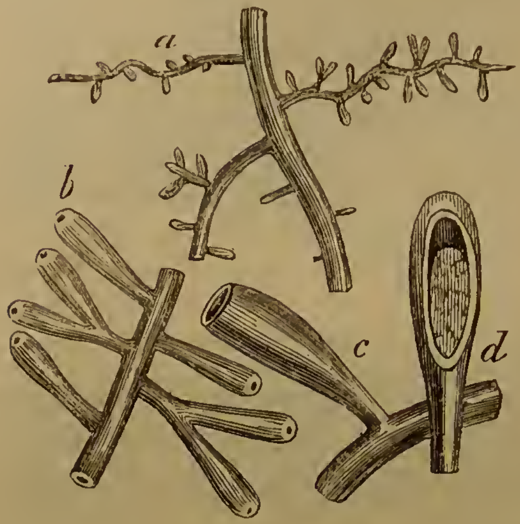
BYSSINÆ.

(399.) As the plants contained in the lower grades of the two superior sections approach so closely to the characters of fungi that they have often been considered such, it is evident that the systematic location of those included in the one now to be examined must be still more debateable. And this will be found to be the case, for *Byssus*, *Rhizomorpha*, and their allies, which form the two types *Byssaceæ* and *Rhizomorphaceæ* of the *Bysso-Lichens*, or Byssinæ, are by some considered as subordinate groups among the *Fungi*, by some among the *Lichens*, and by others, who perceive and confess their affinity to both, they are elevated into an intermediate order independent of either; a rank which they seem to have no just claim to hold, since their distinctions and connexions are sufficiently denoted when they are arranged as the lowest section of the Lichenales bordering on the lower fungi, and running parallel with them.

(400.) Such is their distribution in the present scheme, and such is nearly the rank assigned to them by Fries, with whom Greville agrees in the propriety of their removal from the true fungi. By both these eminent Cryptologists they are defined to be "Aërial Algæ, flourishing perennially, and consisting of a persistent and little changing filamentous texture of turgid fibres, (either free or blended into a common stratum,) and with their fructification external, naked, and homogenous." These characters, which distinguish them as a section of the Algæ, will likewise sufficiently remove them from the fungi, the only other group with which they have any chance of being confounded, if the rudimental states of some higher plants, and certain ambiguous, and probably wholly lifeless productions, be excepted: of which more hereafter.

(401.) *Rhizomorphaceæ*. The *Rootmoss*, (Rhizomorpha,) so

called from the radiciform elongations of its thallus, gives name to the *Rhizomorphaceæ*, the first type in the section *Byssinæ*.



Rhizomorpha divergens.

(*a*) Plant, natural size.

(*b*) Portion with fruit magnified.

(*c*, *d*) Sections of the fruit, or pseudo-perithecia containing spores.

(402.) The several species of the genus *Rhizomorpha*, such as *subcorticalis*, *divergens*, *subterranea*, *phosphorea*, &c., are very common on the trunks of dead trees, especially beneath the bark of firs; in cellars, particularly wine-cellars, among the saw-dust; in lead and coal mines, and other similar situations; thus shewing, by their vegetating in the dark, their secession from the normal Lichens.

(403.) These plants are active agents in decorticating dead trees, and assisting in the disintegration of lifeless organic bodies, which would otherwise encumber the surface of the earth, and be exceedingly tedious in their removal. Portions of bark several feet in length, or even extending from the base to the boll of a large tree, will, when the *Rhizomorphæ* locate themselves between it and the wood, soon become so far loosened as either to fall off spontaneously, or to be unable to resist the slightest external force; and trees thus debarked are quickly preyed upon by Fungi, and other wood-destroying plants and animals.

(404.) Several species, especially *subcorticalis*, *subterranea*, and *phosphorea*, are occasionally phosphorescent, and more or less luminous in the dark; and hence they often give to the cellars and mines in which they grow an extraordinary and brilliant appearance. In the coal mines in the vicinity of Dresden they are said to be so abundant and so luminous, as even to dazzle the eye by the brilliant light that they afford. This light is increased by the warmth of the mines; so that, hanging in festoons and pen-

dents from the roof of the various excavations, twisting round the pillars, and covering the walls, they are said, by their brightness, to give to the Dresden coal mines just mentioned, in which they abound, the semblance of an enchanted palace. Mr. Erdman, the commissioner of mines, thus describes the appearance of the Rhizomorphæ in one he visited:

"I saw the luminous plants here in wonderful beauty; the impression produced by the spectacle I shall never forget. It appeared, on descending into the mine, as if we were entering an enchanted castle. The abundance of these plants was so great, that the roof and the walls and the pillars were entirely covered with them, and the beautiful light they cast around almost dazzled the eye. The light they give out is like faint moonshine, so that two persons near each other could readily distinguish their bodies. The lights appear to be most considerable when the temperature of the mines is comparatively high."

(405.) The type *Rhizomorphaceæ*, characterized by having the sporidia internal, includes, according to Fries, two subtypes, in the first of which the sporidia are contained within a pseudo-perithecium, formed by the collocation of the turgid fibres of the thallus. The thallus likewise, in this subtype, is continuous, radiciform, of a dark colour verging to black, and formed of many filaments blended into a common stratum. *Rhizomorpha* is the normal genus, and hence it is called the *Rhizomorphidæ*. *Ascophora* seems a doubtful ally, although by Fries referred to this group.

(406.) The *Rhizomorpha cinchonarum* is a rare species, but whenever found, it is a sufficient indication of the worthless state of the barks it grows upon, demonstrating by its presence that their medicinal qualities are much impaired, if not entirely cancelled by putrescency.

(407.) *Cœnogonium*, (from κοινὸς and ὠ'νια, the reunion moss,) *Himantia*, the thonglet, (from ʽιμὰς, a thong or bridle,) and Ozonium, (from ὄζος, a branch,) the branch-mould, are examples of the second subtype of the Rhizomorphaceæ, which, from the first-named genus, has been called the *Cœnogonidæ*. In these plants and their allies the sporidia are situated within an open excipulus, which is often, either normally, or from abortion, subascigerous; the fibres of the thallus likewise, although occasionally more or less interwoven, are mostly free, and only subcontinuous; thus shewing, in more respects than one, *e. g.* both by their free and articulated fibres, as well as by the absence of sporidia, an approach to the *Byssidæ*.

(408.) *Cœnogonium* was considered a conferva by Agardh, but this opinion is manifestly erroneous; both its structure and its station plainly indicate its affinity to the Bysso-Lichens.

(409.) *Himantia Cinchonarum* shews, according to Fee, a subputrescent state of the barks on which it is found, and is an evidence that their decomposition is so far advanced, that all specimens which bear it should be at once rejected for officinal purposes.

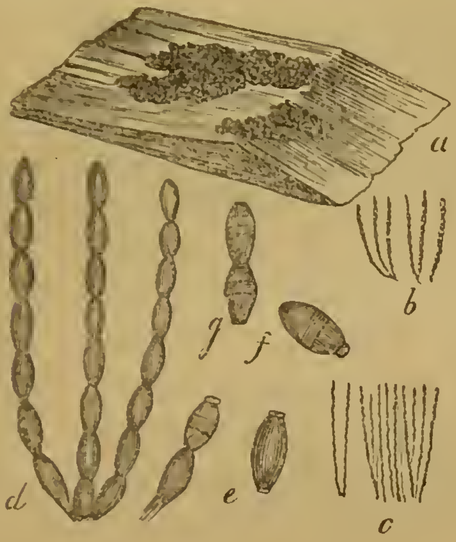
(410.) *Byssaceæ*. *Racodium*, the rag-moss-leather, (from Ῥάκιον, a worthless worn-out garment,) and *Hypochnus*, the undergnaw, (from ὑπὸ and χνανώ,) are among the most common and important illustrations that can be given of the subtype *Racodidæ*, which, with the allied subtype *Byssidæ*, including *Byssus*, the flaxlet, *Monilia* the beadlet, *Aspergillus*, the brushlet, and others, form together the type Byssaceæ.

(411.) The *Byssaceæ* are distinguished by their sporidia, when developed, being external, and the flocci of the thallus being free or subdiscrete; the subtypes are known by the dark cloth-like thallus in the *Racodia* being continuous, and the flocci non-articulate, although in the divisions obscure septa may be traced; while in the *Byssеæ* or *Byssidæ*, the flocci are jointed, moniliform, and discrete. In the *Byssidæ*, likewise, the sporidia are mostly absent, propagation often taking place by division of the thallus.

(412.) The *Mouse-skin rag-leather*, (*Racodium cellare*,) is very common in wine-cellars; forming a kind of whimsical tapestry on the walls and roofs, covering the casks, and investing the bottles with adventitious tunics; when compressed, it resembles the skin of a mouse, and is said to be an excellent styptic. In the wine-cellars under Welbeck chapel, Marylebone, the *Racodium* is so abundant, that it forms a really curious and interesting spectacle. The long vaults in several of the cellars where wine is kept, or where the casks and full bottles are, or where the bottling is carried on, are covered with it, hanging so low as to knock against the men's heads as they go along. In the cellars where the empty bottles are stored very little of the *Racodium* is seen.

(413.) Of *Hypochnus*, an allied genus, two species, viz. the *rubrocinctus* and *nigrocinctus*, [§ 390, E, F,] are found on the barks of various cinchonas. When in any quantity they are bad omens, as plants of this type seldom grow excepting on dead or sickly trees. The *Hypochni* are very repulsive of water, continuing dry even when submerged.

(414.) Of the subtype *Byssidæ*, (or *Byssecæ*,) the *bead-mould*, (*Monilia*,) especially that species known under the name of *blue-mould* in cheese, (Monilia glauca, or *Aspergillus glaucus*,) will form, perhaps, the most familiar illustrations. These little plants, as common experience shews, increase with wonderful rapidity, owing to the vast profusion of their offsets. The latter vary in colour



Monilia attenuata.

(*a*) Natural size.

(*b*, *c*) Filaments separated.

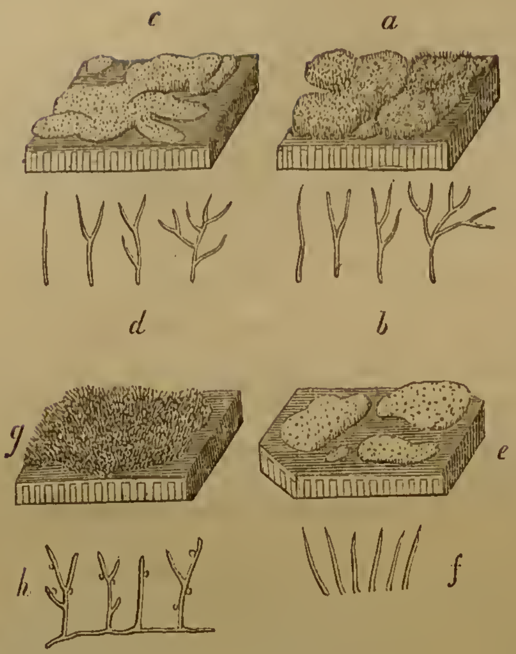
(*d*) Same, much magnified.

(*e*) Disarticulated joints.

(*f*, *g*) Ditto with dark masses within them (? abortive spores.)

from a light to a very deep glaucous hue, and add so much to the epicurean value of cheese, that fraudulent dealers endeavour to imitate the colour given, by the verdigris which is quickly formed on the brass pins that they stick in cheese. Another species, the *penicillatus*, which, with the glaucus, has been separated from the old genus, *Monilia*, under the name of Aspergillus, or *brushlet mould*, is a very elegant plant, of a dark-grey colour, and as common on damp plants in herbaria as the *A. glaucus* is on fruit and cheese.

(415.) Several Byssus-like plants, which I cannot but think are better associated with the foregoing in the present type of the Byssinæ, than with the Confervales, are still retained by many botanists of authority among the confervoid flags. These are chiefly some very doubtful plants, now formed into the genus Chroolepus, which includes the old *Byssus aurea*, *Iolithus*, &c., and a curious group of Bysso-Lichens that are half aquatic. These latter are found on the surface of various chemical and other solutions, such as ink, rose-water, Baryta water, isinglass size, &c. Collectively they are formed into the genus *Hygrocrocis* (or *damp tuft*), and their specific names refer to their various stations, *e. g.*, *H. Atramenti*, the tufts of plants found in ink, *H. Rosæ*, the beautiful roundish floating masses of down seen in rose-water, and so on. Whether *Myci-*



(*a*, *b*) Byssus aurea.

(*c*, *d*) ——— viridis.

(*e*, *f*) ——— Iolithus.

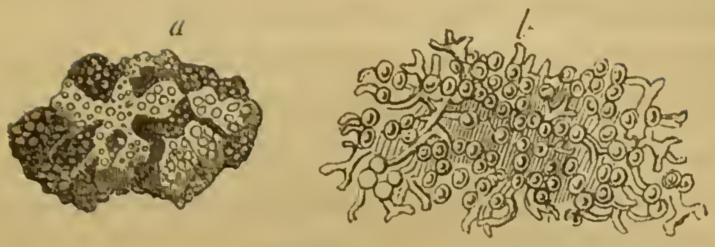
(*g*, *h*) ——— velutina.
The opacity of the filaments prevents the articulations being easily seen in these plants.

nema, *Trentepholia*, and *Leptomitus*, should be retained in this group seems very questionable.

(416.) *Byssöidaceæ.* Various apocryphal vegetable productions in which neither spores nor sporidia can at any time be traced, and which, although probably in some cases, the abortive or rudimentary states of decided *Byssines* cannot be referred with certainty to any known genera, are associated, to close this section, in a type denominated the *Byssöidaceæ.* These are the *Byssaceæ spuriæ* of Fries; and among them will be found the doubtful genera *Lepraria*, *Tophora*, *Phyllerium*, &c. which are examples of the three groups into which the German Lichenologists distribute them, and which might hence, were such distinctions needed, be named the subtypes *Lepraridæ*, *Tophoridæ*, and *Phylleridæ*.

(417.) Of the doubtful nature of the *Lepraria* or *leprous-worts*, notice has been already taken; and of several of the species once included in this genus, such as *latebrarum*, *æruginosa*, *Iolithus*, and *chlorina*, Greville, in his Flora Edinensis, observes, "I confess myself at a loss to know what to do." The first, however, which he acutely observed, even in 1823, was not a Lepraria, Fries has shewn to be the early state of a *Cladonia*, and the same fate has befallen *æruginosa* and *velutina*. The Lepraridæ are, therefore, now confined to those asporous *Byssöidaceæ*, which arise on, and from, the dead and decaying structure of various plants.

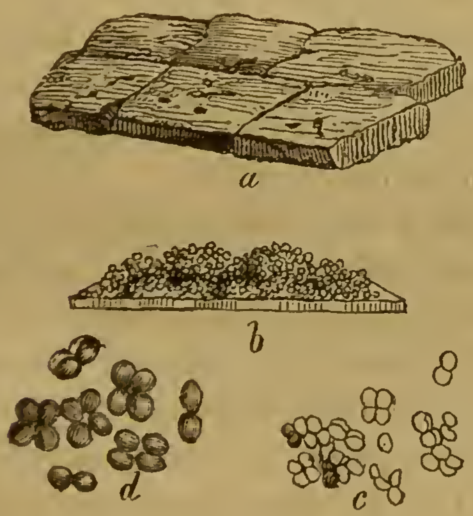
Alyspheria (Lepra) candelaris.



(*a*) Natural size. (*b*) Portions magnified to shew its hypothalline form.

(418.) The *Byssus crypturum*, of old writers, is the present *Tophora*, which, with certain threadlike productions, not epiphytic, but found on the bare soil, and formerly confounded with *Byssus velutina*, but now distinguished by the name of *Herpotrichum*, forms the subtype *Tophoridæ*. The colour of the Tophoridæ is usually green. They are asporous, and by some supposed to arise from the germination of the spores of Ferns and Mosses being arrested in their rudimental states. *Byssus velutina*, as already observed, has been proved to be the infant stage of *Polytrichum Alöides*.

(419.) Whether *Chlorococcus* (or Chlorococcum), *vulgaris*, *murorum*, &c. should be separated generically from the *Leprariæ*, is



Chlorococcum vulgare.

(*a*) Natural size; on wood.

(*b*) Group of plants magnified.

(*c d*) Ditto, removed from the wood, and magnified to shew their simple cellular structnre.

a question of slight importance; so that the species are situated near each other, it little matters whether two genera are made, or the whole be re-associated in one. They are usually kept distinct, but by Hooker, I perceive, they are conjoined: they are some of the simplest plants existing, being, in the air, what the *Globulinaceæ* are in the water: thus connecting the extremes of

this extensive class. They abound on old palings, damp walls, the trunks of trees, and other similar situations [§ 41.]

(420.) Several folliculous or leaf-dwelling epiphytes, more or less abounding on living leaves, especially the maple, pear, alder, birch, walnut, hawthorn, rose, &c., the growth of which is favoured, if they themselves are not wholly produced, by a degenerate evolution of the cellular structure of the plants on which they are found, are associated to form the third subtype of the *Byssöidaceæ;* and, from their habits, they have been called the *Phylleridæ,* (or Phylleriaceæ.) Sometimes the whole of these plants, from their prickly erinaceous appearance, have been included in a genus called *Erineum,* but at others they have been distributed into several subordinate groups, *e. g. Phyllerium, Erineum,* or *Grumaria,* and *Taphria,* the origin of which last is said by Fries to be dependent on meteoric changes.

(421.) Pseudo-Byssöideæ. As an appendix to the *Bysso-lichens,* and being on the confines of the organic and inorganic realms, cryptologists enumerate several Byssus-like productions, under the names of *Hypha, Lanosa,* &c., and call them collectively *Byssaceæ falsæ.* These pseudo-Byssi seem to be chiefly of meteoric origin and atmospheric growth. Occasionally they occur in vast profusion, and their advents are irregular and sudden. The *Lanosæ* are those subfugacious filaments resembling the lines of spiders' webs, and the *Hyphæ* similar productions, but much more speedily deliquescent and found chiefly in damp caves and cellars, while the others are most frequent in the open air.

(422.) One sort of honey-dew, it is even thought, may be owing to the deposition of similar meteoric subvegetations, or, perhaps, to be the abortive phyco-matrices of various Byssine Algæ, the vitality of which has been destroyed by atmospheric changes. Several of the more remarkable visitations of these meteoric or pseudo-Byssöidaceous productions have been placed on record, from time to time, as they have occurred. One of these was noticed in Germany, in the month of April, 1709; another at Dresden, in August, 1751; and others in Bohemia, and various distant places. And it is furthermore a question, whether the appearance of some of the so-called falling stars, and many other meteoric lights, may not be owing to the phosphorescence or electrical combustion of these aërial formations, whether they be of vegetable origin or not.

(423.) Here closes the third and last section of the Lichenales,

and with it the first class, *The* FLAGS, or ALGÆ; a very extensive and a very important class. Reducing the Lichenales to a similar tabular conspectus with the two preceding orders, the following will be the form of their linear arrangement:

ORDER.	*Sections.*	*Types.*
LICHENALES	Cetrarinæ.	Parmeliaceæ. Graphidaceæ.
	Verrucarinæ.	Pertusariaceæ. Verrucariaceæ.
	Bysinæ.	Rhizomorphaceæ. Byssaceæ. Byssöidaceæ.
	Pseudo-Byssöideæ.	

GEOGRAPHICAL DISTRIBUTION OF THE LICHENALES.

(424.) The distribution of the Lichenales chiefly assumes a topographical rather than a geographical interest. This will already have become apparent from the notices of stations so frequently introduced, and by which they have been shewn to become such admirable guides in the distinction of some of the officinal barks; and moreover, indexes of the states of their preservation: their general statistics will be found, however, not wholly unworthy of attention.

(425.) The whole number of known species of this order has been estimated by Fee at between two and three thousand. This, however, is probably too high a sum, even including the Byssinæ, many computed by him being only varieties.

(426.) Geographically considered, they are, in the first place, aerial plants, and their range is most extensive: proceeding either from the poles, or descending from the polar heights of hills, they are found to be first heralds of life, encroaching even on the confines of perpetual snows, vegetating at a temperature below the freezing point; and they cease not to struggle against every impediment to vegetable growth, for they flourish even among the burning sands of *Africa*, and in the hottest and driest regions of the torrid zone. Wherever light comes Lichens grow, but they are rarely produced in obscure places. When deprived of light, they degenerate in their forms, and it is the lowest section only, viz. those approaching to the Fungi, that vegetate in the dark. So little is heat regarded by these plants, that when utterly parched by months of drought, they revive when rain returns; and even if hot water be poured over them, they are not destroyed. Heat seems rather to favour the development of their fructification, for in the hottest and driest places their apothecia the most abound.

(427.) With regard to the general geographical distribution of the European Lichens, and no others have been hitherto studied with sufficient minuteness to allow generalizations to be made, Fries gives the following summary account. In the southern parts of Europe, on the shores of the Mediterranean Sea, there are found several species of tropical genera, which likewise occur in the warmer regions of America; such as *Chiodecton* and *Dirina*. From this southern district, it is believed that other more northern Lichens are absent; such as *Parmelia tartarea*, the *Umbilicariæ*, &c.; while *Evernia villosa*, *Ramalina pusilla*, *Cladonia endiviæfolia*, and many *Parmeliæ*, are present. The *Graphidaceæ* are also here abundant.

(428.) Along the whole western coasts of the Atlantic, even from the south of Spain to Finmark, many of the same Lichens are common; such as Ramalina scopulorum, and various Strictæ and Parmeliæ: the moist atmosphere and more agreeable temperature of a maritime station favouring the extended range. This tract, however, may be subdivided into northern and southern regions: in the latter, the *Roccella tinctoria*, *Sagedia aggregata*, and numerous *Verrucariæ*, and *Graphidaceæ* are found; in the former, *Parmelia gelida*, *Biatora atrorufa*, and the *Umbilicariæ*, predominate.

(429.) In the Arctic regions, as in Iceland, and especially in the Alpine parts of Lapland, the *Cetrariæ* and *Cladoniæ* prevail: the former flourishing on the tufa and volcanic scoriæ; the latter clothing an otherwise barren soil, even from the sea-shore to the summits of the mountains. In these districts, *Evernia vulpina*, and many other Lichens, cease to grow; as the Calicia do in warmer regions: for Fries observes, that in the tropics, these last-named Lichens are unknown. *Usnea barbata* and *Cladonia pyxidata*, and a few others, are quite cosmopolites, for they occur in almost every region.

(430.) Thus it will be perceived, that the Phyco- and Myco-Lichenes, *i. e.* the *Verrucarinæ*, with a large proportion of the *Byssinæ*, although not confined to, predominate in the southern parts of the temperate zone; while, on the contrary, the Bryo-lichenes, *i. e*, the *Cetrarinæ*, become most abundant in those regions that verge towards the pole.

(431.) Fries observes, that the *Verrucarinæ* are so numerous in the southern regions, that it would almost seem as if the excess of heat had driven the tribe to take refuge under the epidermis of

trees. As vegetation is far less luxuriant towards the north, it is not surprising that Epiphytic Lichens become rare, and at last wholly cease, in more and more northern regions, and on the northern altitudes of hills; and that the saxicolous species, in a great measure, characterize, by their abundance, the Arctic zone. Although the geographical range of the Lichens is thus most extensive, spreading as they do over the whole earth, from the equator to the poles, still they would seem on the whole to be plants rather of the northern than of the southern regions, for their numbers gradually increase, not only relatively, as compared to other plants, but positively also, in the higher latitudes, until at length they remain alone—the last which yield to the exterminating power of cold. The properties, likewise, which they possess, seem to be more fully developed in the northern than in the temperate and torrid zones.

(432.) As to special stations, the utmost variety prevails: they grow on the trunks of trees, on their leaves, on dead wood and stones of the hardest kinds, Biatora decipiens is said even to vegetate on iron; and others, as the Byssocladium fenestrale, spread their fibres over glass. Many of these stations have been already noted, and their topographical interest is great.

(433.) The physical services of the Lichens also, in overspreading sand, volcanic scoriæ, ashes and lava, in disintegrating rocks, and first planting Flora's standard on tracts thus claimed, and subsequently colonized by plants of other tribes, which follow the footsteps of these vegetable bond-slaves, should never be overlooked. In the general introduction [§ 54,] these circumstances have been described. Instead therefore of repeating what has been already said, the following quotation from one of nature's truest poets, may recal the subject to the reader's mind:

> "Seeds to our eyes invisible, will find
> On the rude rock the bed that fits their kind;
> There in the rugged soil they safely dwell,
> Till showers and snows the subtle atoms swell,
> And spread the enduring foliage; then we trace
> The freckled flower upon the flinty base;
> These all increase, till in unnoted years
> The stony tower as grey with age appears,
> With coats of vegetation, thinly spread
> Coat above coat, the living on the dead:
> These then dissolve to dust, and make a way
> For bolder foliage, nursed by their decay:

> The long-enduring Ferns in time will all
> Die and depose their dust upon the wall;
> Where the winged seed may rest, till many a flower
> Shews Flora's triumph o'er the falling tower.
>
> CRABBE.

(434.) Although the *Lichenales* have so wide a geographical range, being spread over the whole surface of the globe, from the Tropics to the Poles, not a single specimen has hitherto been found in a fossil state. This confirms the conclusion which the occurrence of the *Marine* Algæ in the older strata supports, viz. the prevalence of the waters over the surface of the globe during a certain geological epoch. Lichens, which are aërial plants, being saxicolous or chiefly epiphytic, of course, could not exist before the rocks were raised from the bosom of the deep, or plants were growing on the land. The stone-dwelling Lichens would probably be the forerunners of the other tribes; but their very minute size and pulverulent structure may sufficiently account for not any traces of them having hitherto been found. And the remains of trees, and other land plants, which abound in the coal formations, and in the tertiary series, are, for the most part, so much injured, their stems compressed, their leaves separated, and their different parts often so greatly dismembered and disguised, that it is not to be wondered at that no relics of Lichens have been discovered on them, or their impressions distinguished from the natural or accidental markings with which such specimens are overspread.

(435.) This outline sketch of the natural history and systematic arrangement of the Algæ may perhaps be best concluded, by reducing the whole three orders the class contains to the form of a tabular conspectus, similar to those in which the several types and sections have been synoptically disposed.

	Class.	Orders.	Sections.
Algæ	Lichenales.	Byssinæ.	[400. 405. 411. 416.]
		Verrucarinæ.	[393. 395. 397.]
		Cetrarinæ.	[362. 377. 386. 387.]
	Fucales.	Fucinæ.	[249. 264. 267. 268. 270. 276. 290.]
		Florinæ.	[249. 251. 253. 255. 261. 262.]
		Ulvinæ.	[239. 243. 244. 246.]
	Confervales.	Confervinæ.	[178. 189. 195.]
		Nostochinæ.	[137. 152. 154. 155.]
		Fragillinæ.	[136. 140. 142.]

NOTE.—The figures refer to the sections in which the associating characters of the several groups and subdivisions will be found.

2

OUTLINES OF FUNGOLOGIA.

(436.) Several extensive groups of very extraordinary plants, many of which are known familiarly as Blights, Blasts, Mildews, and Mushrooms, are associated to form the second class of the first region of the vegetable reign; and they are collectively denominated Fungi.

(437.) Many doubts have been entertained as to the exact nature of these plants, some persons, as Scopoli, Weiss, and Büttner, believing them not to be vegetable, but animal productions; while others have denied that they were either; and have not scrupled to describe them as the fortuitous effects and offspring of corruption. Other naturalists, again, have considered them as beings of so peculiar and distinct a kind, that they have formed them into a separate kingdom, holding an intermediate rank between the animal and vegetable reigns; and Munchausen once contended that, although neither animals nor plants, they were the work of insects, and built up by them as corals are by polypes.

(438.) But all these speculations have been shewn to be based on error, and no one now denies that Fungi are truly plants. Many fungöid diseases to which leaves and stems are subject, and morbid growths, which are common to all parts of vegetables, must, however, be excluded; for, notwithstanding they have been named and arranged as fungi by some celebrated Mycologists, they have no right to be considered such, any more than the chemical changes attending putrefaction, which are likewise contemporary with the growth of fungi.

(439.) Fungi and insects have not inaptly been called 'the scavengers of nature,' for both labour, and with most astonishing effect, in the removal of refuse matters, which, were they left on the surface of the earth, would be found not only useless incum-

brances, but injurious tenants. The fungi are for the most part parasitic plants, and chiefly grow on dead and decaying animal and vegetable substances. These they help to disintegrate and dissolve, and speedily remove, converting the exuviæ of one generation into manure and vegetable mould, for the support and sustenance of the next. For these duties their minute seeds and wandering habits, [§ 55, 57,] particularly suit them. The vapour-like sporules of fungi float about in the atmosphere in countless myriads, only waiting for the presence of a fitting soil on which to alight and grow. By an admirable law, it is provided that these vegetable legions are confined to parasitic soils, and hence, as long as there is no refuse matter to be removed, the spores remain dormant, (the scavengers are unemployed;) but as soon as ever a quantity, be it large or small, of decaying animal or vegetable matter is left exposed, so soon is it covered with spores, which quickly develop themselves into fungi of various kinds. Owing to their rapid growth, fungi have been said to be never in their nonage, but to spring at once to maturity, and almost to enter the world full-grown; which, added to their astonishing fruitfulness, renders their history one of peculiar interest. Each individual of those minute fungi which are only noticeable when in legions, and which are known as smut in corn, has already been stated to produce, according to the calculation of Fries, upwards of 10,000,000 sporules; and other species have been proved to grow at the rate of between sixty and seventy million cells per minute.

(440.) Hence, what has been said of their fellow-labourers, insects, will apply with equal truth and force to these nomadic tribes; and therefore Lyell's statement of the question shall be quoted with only a few slight verbal alterations. "The peculiarity of their agency consists in their power of suddenly multiplying their numbers, to a degree which could only be accomplished in a considerable lapse of time in any larger beings, and then as instantaneously relapsing, without the intervention of any violent disturbing cause, into their former insignificance.

"If, for the sake of employing on different but rare occasions a power of many hundreds or thousands of horses, we were under the necessity of feeding all these animals at great cost in the intervals when their services were not required, we should greatly admire the invention of a machine, such as the steam-engine, which

was capable at any moment of exerting the same degree of strength, without any consumption of food during the periods of inaction, and the same kind of admiration is strongly excited when we contemplate the powers of insect and fungus life, in the creation of which nature has been so prodigal. A scanty number of minute individuals, only to be detected by careful research, and often not detectable at all, are ready, in a few days, or weeks, to give birth to myriads, which may repress or remove the nuisances referred to. But no sooner has the commission been executed, than the gigantic power becomes dormant; each of the mighty host soon reaches the term of its transient existence; and when the fitting food lessens in quantity, when the offal to be removed diminishes, then fewer of the spores find soil on which to germinate; and when the whole has been consumed, the legions before so active, all return to their latent, their unnoticed state; ready, however, at a moment's warning, again to be developed, and, when labour is to be done again, again to commence their work, either in the same districts, or to migrate in clouds, like locusts, to other lands. In almost every season there are some species, but especially in autumn there are many, which in this manner put forth their strength; and then, like Milton's spirits which thronged the spacious hall, 'reduce to smallest forms their shapes immense:'

> "So thick the aëry crowd
> Swarmed and were straitened; till the signal given,
> Behold a wonder; they but now who seemed
> In bigness to surpass earth's giant sons,
> Now less than smallest dwarfs."

(441.) Fungi have been very variously distributed, and the subordinate groups very variously named; and it is to be lamented, that much doubt and uncertainty still exists as to the extent of the several groups, and the boundary-lines by which they should be demarcated. Different Mycologists greatly differ in their arrangements, but they all more or less agree with the popular distribution into *Blights*, *Puff-balls*, and *Mushrooms*. These are then the groups which will be adopted in the subsequent demonstrations.

(442.) In the first of these three orders are arranged the Blights, Blasts, Brands, and Mildews, some of the smallest, and yet, from their numbers, some of the most powerful and destructive fungi known. They have been called MUCEDINALES, from Mucedo,

mouldiness, or Uredinales, from *Uredo*, the Brand; and sometimes, from their sporidia being naked, *Gymno-mycetes;* thus including the Coniomycetes of Fries and other authors.

(443.) In the second order will be found the Puff-balls, Ground-stars, and Truffles. Hence they are called, collectively, from Tuber, the Truffle, TUBERALES; or by some Mycologists *Gastromycetes*, from the reproductive organs being enclosed in a ventricose pouch. Some of the tuberiform fungi grow to a most amazing size, being two or three feet or more in diameter, so that such large rounded masses of a tawny colour have been mistaken by travellers, in tropical countries, for couching lions.

(444.) The third order contains the well-known eatable Mushrooms, and many poisonous species, which are commonly designated toadstools. This group is called BOLETALES, *Mycetales*, or Hymenomycetes. It is probable that it was to the plants contained in this order that the original Greek μύκης, like the modern French champignon, was particularly applied: as, in reference to the common form of the plants, both terms are peculiarly appropriate, resembling, as many of these fungi do, the handle of a sword, and others, the pinion of a watch.

(445.) These three orders, into which the subordinate types and sections are associable, are not, however, three widely separated groups, but only diverse portions of one entire though extensive district; all as it were setting out from a common central point, at which they are intimately connected, though pursuing, in their development, very different courses. Hence is it that the plants constituting mustiness, mouldiness, and mildew, though all different, and some of them belonging even to different orders, are confused in popular examinations, and undistinguishable by the untutored eye.

(446.) There is something very peculiar and characteristic, though scarcely expressible in a few words, in the general aspect of the fungi. They are destitute of most of the external organs which are common to other plants; they have neither flowers nor leaves, nor any members which shew the slightest resemblance to them; and even their stem, when present, is unlike the stem of other plants.

(447.) In their colouring everything is reversed. Green, which in general so greatly predominates, among them is rare, and when it does occur, as in *Peziza æruginosa*, it is a lurid metallic tint,

wholly at variance with the soft green hues of ordinary foliage. Colours of the most shewy and brilliant kinds are common amongst the fungi; and so splendid are the tints, as compared with those even of many flowering plants, that, as Dr. Flemming truly observes, in colouring figures of the fungi, there need be little apprehension entertained of committing excess; while, in the coloured drawings of the more perfect plants, the artist is sometimes too profuse in tints, and the figures exhibit a gaudy appearance, which offends the eye, as it swerves from truth. Nature having withheld from fungi those flowers which form the chief beauties of the higher orders, and even the leaves with which they are clothed, has profusely scattered her colours over the whole surface of the mushroom, ornamenting the cap with one colour, the gills with a second, the stem with a third, and often blending in stripes, or shading two or three tints into each other; as in Agaricus psittacinus, Amanita imperialis, and others.

(448.) Hence, let the lover of natural history but free his mind from prejudice, and then examine the forms and colouring of these far too much-neglected plants, and he will be compelled to admit that many of the fungi rival, in symmetry and splendor, the tulip and the lily, those gaudy favorites of the world at large.

(449.) As was the case with the Algæ, several doubtful fungöid productions form one of the acknowledged boundaries of this class, such as the fungus-like matter found amongst fermenting grain, which has been called *Spermoedia*, and various morbid states of plants in which the cellular structure extrudes, forming sometimes closed, and sometimes open tumors. These, however, though once considered fungi, are now recognised as diseases, or their effects; and other doubtful fungi will probably hereafter meet a similar fate.

(450.) Fungi, especially of the smaller kinds, are found to spring profusely on mucous or slimy matter, such as exudes from trees when wounded, and is likewise seen in other situations; hence, as it forms a nest or nidus for the reproductive organs of the fungi, (which are collectively denominated Mycelia,) it has been called the Myco-mater, a term analogous to the Phycomater of the Algæ.

(451.) The pseudo-mycetes, (false fungi) *Spermoedia*, *Strumella*, *Nosophlœa*, &c., are analogous to the pseudo-byssöideæ, *Hypha*, *Lanosa*, &c., and are placed, like them, in an appendix; not being

admitted to be truly fungi, although connecting the organic with the inorganic world. And the *Myco-mater*, though possessing a similar name, is not a production equivalent to the *phyco-mater* of the Algæ, as it is merely an adventitious nidus, and not in any case produced by the degeneration of the mycelia, or rudiments of fungi. Indeed, the chief distinction between the lower Algæ and Fungi, especially between the conterminal sections *Byssinæ* and *Uredinæ*, will be found to depend upon the relative evolution of the thallus or organ of extension, and the *sporidia*, or special organs of reproduction.

(452.) In the Algæ the *thallus* is always present, and often, by division of its substance, furnishes the reproductive germs for the propagation of the species; the spores being frequently abortive, or altogether wanting, while, in the fungi, the sporidia or spores are as universally present, although the thallus is often absent, the plants consisting of the reproductive organs only.

(453.) Thus, the evolution of the Algæ and the Fungi would appear to take place on directly opposite principles, in the one the thallus, in the other the spores, being with the most certainty developed; and hence the dogma that, as the *thallus* is essential to the *Algæ*, so the *sporidia* or *spores* are essential to the *Fungi*.

MUCEDINALES.

MUCORALES, OR UREDINALES.

(454.) The first order in this class, which, from either of the three most important genera, *Uredo*, *Mucor*, and *Mucedo*, might be called indifferently *Uredinales*, *Mucorales*, or *Mucedinales*, includes all those fungi which either consist of sporidia alone, unconnected by any common receptacle (thallus), or in which the sporidia are unaccompanied by any of those organs subsequently to be described under the names *hymenium*, *perithecium*, and *peridium*.

(455.) Hence these fungi have by some been called the *Gymnomycetes;* but sporidia really naked rarely occur among the fungi. A few are absolutely destitute of any covering, but others, although possessed of no true tunic, take an adventitious one in their early stages of development from the cuticle of the plants on which they grow, and through which they burst. Occasionally, even prolongations of the receptacle form a fugacious tunic.

(456.) The order *Mucedinales* is equivalent to the cohort *Coniomycetes* of Fries; the *Hyphomycetes*, which by most authors are retained amongst the fungi, I am persuaded, have with propriety been removed, by the above-named celebrated Cryptologist, to the Bysso-Lichens: and they have been already described, along with their true associates, the other Lichenales.

(457.) But although arranged in different classes, the Myco-Lichens and the Mucedinales, which are on the confines of the two departments, are more closely connected, and have more characters in common than any other orders; and here the principle so often insisted on may be again repeated, that, in the distribution of the natural groups of the vegetable world, it is not only their distinctions, but their connexions, which should be diligently sought out.

UREDINÆ.

(458.) UREDINACEÆ.* *Uredo*, the Brand; [§ 458, fig. 469.], *Æcidium*, the Blast; *Puccinia*, the Blight, [§ 469, fig. I, J, K.] with other allied genera, constitute, together, the type *Uredinaceæ*. The

(*a, b*) *Uredo candida* on the stalk and leaves of Capsella Bursa pastoris.

(*c*) Portion magnified, showing the false tunic, formed of the integument of the Capsella, burst and exposing the sporidia.

(*d*) *Uredo candida* on a cabbage leaf, before rupture.

(*e*) After rupture.

(*f*) Sporidia magnified.—*Grev.* 251.

* Fries called this type Hypodermii; but he states his opinion, in a note, that the name ought to be changed for one derived from some normal genus.

group is distinguished by each plant consisting of a sporidium only, and by these sporidia, although often associated in myriads, not being connected by any common receptacle. They grow in the parenchyma of living plants, the epidermis of which forms for them, during their early stages, an adventitious tunic, through which they burst in the progress of their development. [see § 458, fig. D. E.]

(459.) *Blight*, like *Brand* and *Blast*, is a term which has been popularly applied to all these small fungi, indifferently, and is indicative of the former opinion, still entertained by many, that the plants affected by them have been star-struck, burned, or blasted by some atmospheric or planetary influence; names which were given in ignorance, thus being retained long after the error has been detected, and the truth revealed.

(460.) The different species of *Puccinia*, or *tuft-blight*, are exceedingly common on the leaves of various plants; such as roses, violets, and brambles, as well as on grasses and sedges, from which parasitic situations they generally take their names: *e.g.* Puccinia graminum, [§ 459, fig. I, J.], P. phaseolarum, P. rosæ, &c. &c. The leaves affected are frequently studded so thickly with the Pucciniæ, collected into their elegant little tufts, as more than to compensate, by the additional beauty they confer, the apparent injury they inflict upon the plants.

(461.) *Cylindrosporium* is a beautiful and very curious fungus, consisting of distinct cylindrical sporidia. It is found upon the leaves of the common cabbage, and, from the fungi being all elegantly arranged in concentric circles, it has received the name C. concentricum.

Spilocæa, and *Nævia*, allies of *Cylindrosporium*, afford, with it, as to structure, examples of the simplest fungi known; the last consisting only of elongated sporidia collected into circles, and the first of similar simple subglobose sporidia, crowded into larger or smaller groups, and forming the spots, usually of a black colour, which are common on apples, and other fruit. When the sporidia are solitary, so that only small black dots are visible, they have received the name of *Næviæ*.

(462.) Æcidium, the blast or dust-blight, is likewise another very common fungus, parasitic on living plants. It abounds on the leaves of the colts-foot, gooseberry, berberry, &c. For the most part, the species are of a bright orange or reddish brown

colour, and thus add much to the variety and beauty of the leaves on which they grow.

These, as well as other parasites, are most curiously restrained as to the plants which they attack ; for, while some vegetables are annually infested with Æcidia, others are invariably exempted from their attacks. The circumstances which determine this choice are, as Johnson observes, entirely unknown. Examples of this liability and exemption occur even in the same genus; thus the gooseberry bears æcidia in abundance, while the red and the black currants, although cultivated in the same soil and situation, remain free from their attacks. This is the more remarkable, because, though the currants are decidedly indigenous plants, the gooseberry is a very doubtful aboriginal native.

(463.) The most important genus in this type, and indeed in the whole section, is the *Uredo*, so named from *uro*, to burn, as the corn affected by some species appears as if scorched, and the husks contain a black powder resembling soot or charcoal. There are many species of Uredo, all of which are closely allied to the Æcidia, of which latter group they are, by some authors, considered a subdivision. From the Æcidia they are, however, sufficiently distinguished by the irregular rupture of their *false tunics*, (*pseudo-peridia*,) [§ 458, *c*, *e*,] which, as before observed, are furnished by the cuticle of the plants on which they grow. Fries likewise states that the pseudo-peridium, which in the Uredines consists of the epidermis only, is in the Æcidia thickened by the elevation of a part of the parenchyma also.

(464.) The Uredines are of different colours, and hence several subordinate groups have been attempted to be formed, called *Albugines*, *Rubigines*, and *Nigredines ;* but their generic distinctions have not been satisfactorily established.

Most of the species of Uredo are common, and they are found upon a great variety of plants, such as the Compositæ, Labiatæ, Rosaceæ, Cruciferæ, Gramina, and many others; but those which, above all, are the most fatally interesting, are the *smut* (*Uredo segetum*, or *carbo*,) and the *canker-brand* (*Uredo caries*, or *fetida*.)

(465.) These plants, which, in the general economy of nature, are designed to effect much good, in checking the over-predominance of certain species, which, if unrestrained, would extirpate others less hardy and vigorous than themselves, when they attack corn-lands, often commit most fearful devastations. Indeed, they

become pests, which keep the farmer in a constant state of agitation; for, so insidious are their advances, that large tracts are laid waste, and the harvests of the year annihilated, before a suspicion of harm has entered the owner's mind.

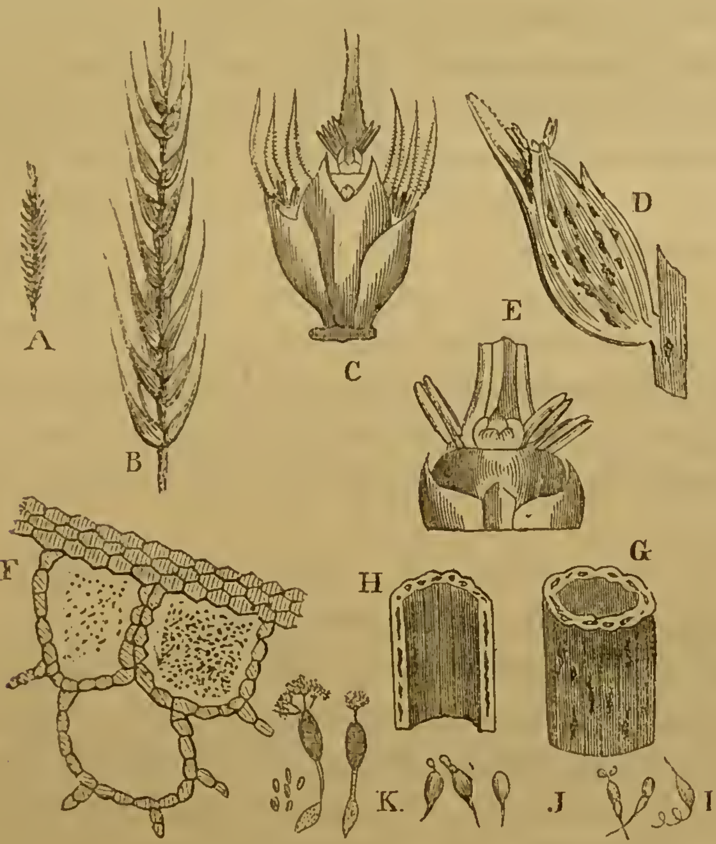
(466.) The eye of science, it is true, will often be enabled to detect the evil in an early stage, by the unusual size and luxuriance of the diseased culms, which frequently exceed in stature, and to a very considerable extent, the healthy stalks, which spring either from the same root, or from contiguous plants. This fatal luxuriance, which deceives the untutored boor, is attributable to the constant excitement which the fungi keep up, and the preternatural state of stimulation in which the growing corn exists. Some persons have accounted for the excessive growth by supposing that the fungi chiefly attack plants growing in the richest and most fertile soils; but similar differences are found not only in plants growing in the same field, but in the several culms springing from the same root.

(467.) There are two species of Uredo, which the farmers, in different districts, call smuts, brand-dews, dust-brands, scorch-blasts, brand-bladders, pepper-brand, canker-brand, burnt corn, &c. The one, *Uredo segetum*, the smut or dust-brand, attacks all the cereal grasses, such as wheat, oats, barley, rye, &c.; the other, *Uredo fetida*, canker-brand or brand-bladders, has hitherto been found on wheat alone.

(468.) The late Sir Joseph Banks instituted a laborious series of observations and experiments, to elucidate the obscure history of these extraordinary parasites; and he engaged the invaluable microscopic hand and eye of Mr. Bauer, to assist him in prosecuting these researches. The drawings then made are deposited in the British Museum, and the last-named naturalist has lately published some excellent figures of both species, with a condensed account both of his former and subsequent observations.

(469.) Mr. Bauer is of opinion, with Fee and others, that the spores of the Uredines, which are of extreme minuteness, (Fries says, as subtile as smoke,) are absorbed by growing grasses, and other plants on which they are found, along with the fluid nourishment they derive from the soil; and experiments, in which the spores of the Uredines were mixed with the soil, and sound wheat subsequently became diseased, have proved the truth of the opinion. The spores, thus conveyed through the sap-vessels of the plants,

pervade their most intimate structures, and, when lodged either in the parenchyma of the stem, or of the ear, prevent the growth of those parts. At first, the stimulus, like the puncture of insects, excites to undue and precocious development; but subsequently, instead of the normal metamorphoses taking place, the several organs remain abortive in their earliest forms, (as shewn in the adjoining figures,) and the cellular structure becomes distended by innumerable fungi.



A. Young ear of barley, natural size, affected by *Uredo segetum*.

B. Ditto, fully grown, before the dispersion of the Uredo; natural size.

C. Three flowers, springing from a common axis, taken from the ear A, and viewed internally.

D. Longitudinal section of the central flower of fig. C: shewing the common axis of the ear; external, internal glume, or husk; axis of the spikelet or peduncle of the flower, filled with sooty-like matter of the Uredo; abortive stamens; abortive ovary.

E. Summit of the same degenerate mass, occupied by the abortive stamina and pistils.

F. Transverse section of a part of the degenerate fleshy mass, shewing the smut. Epidermis, shewing dissepiments between the spaces, which are filled with the granules of Uredo segetum.

G. Transverse section of the culm, shewing the devastations of these parasitic fungi.

H. Longitudinal section of ditto.

I. Puccinia graminum.

J. Puccinia phaseolorum.

K. Puccinia mucronata, with the sporidia escaped.

(470.) It is a fact worth notice, that when, as is usually the case, many culms (twenty or thirty) spring from the same seed, they are not commonly all diseased, but some remain healthy, while others are infested with the parasites; and again, that even in the same spike, or spikelet, some grains are diseased, and others sound.

(471.) The Uredo segetum and Uredo fœtida are easily distinguished from each other, not only from the difference in their size, (the latter being at least twice as large as the former,) but likewise from their essentially diverse methods of attack. The canker-brands are like a troop of sappers and miners, who carry on all their operations secretly, and often complete their work before its commencement has been suspected. Thus, while externally the ears look fine and sound, and the husks healthy, so that they are often reaped and housed, the whole farina of the grain has been consumed, or aborted, and its place usurped by a greasy, sooty-looking substance, which swells them beyond their ordinary size, and which has a most powerful and fetid odour, resembling that of putrid fish; so that, if threshed with sound corn, the sample is considerably injured, and, if in any quantity, rendered unfit for food.

(472.) The smut, on the contrary, soon becomes evident externally; for its attacks are not confined to the grain, but it equally affects the husks, leaves, and culms. Hence it distorts the entire plant, which becomes more or less shrivelled up, as if scorched and dusted over with charcoal; for the Uredo segetum quickly bursts, and discharges the sporules; whereas, the Uredo fœtida seldom ruptures the teguments of the grain, and thus it remains concealed until the corn is threshed. Furthermore, the smut (U. segetum) is scentless, while the canker-brand (U. fœtida) gives out, when crushed, a most intolerable stench.

(473.) It has been said that Uredo fœtida is double the size of Uredo segetum [§ 471,] but, although this is the case, both plants are extremely small. Of the largest, Bauer computes that "no less than two millions five hundred and sixty thousand individual fungi would be required to cover one square inch;" and that of the other "no less than seven millions eight hundred and forty thousand would be required to cover a similar space." Furthermore, Fries has calculated that each of these fungi contain upwards of ten million spores; an approximation, even amongst living organisms, to an infinite division of matter. When highly magnified,

the maternal tunic, which contains the myriads of sporules just mentioned, is seen to be of a reticular texture, and the spores within have the appearance of cellular structure.

(474.) Very numerous schemes have been devised, and many plans tried, with variable success, in order to restrain the devastations of these fungi, if not entirely to extirpate such fearful pests.

In ancient times, when the true nature of these visitations was unknown, religious ceremonies were chiefly resorted to for the purpose of averting the presumed anger of heaven, or of appeasing a supposed offended deity. The Romans, in consonance with their established customs, deified the cause of their distress, and, after the apotheosis of the brand, it was worshipped under the name of Rubigo. The *Robigalia* were propitiatory sacrifices and feasts instituted in honour of the god: they were held the beginning of May, at which time Rubigo was besought to let the corn escape his fearful blasts. Since, however, the true nature of these blasts and brands has been discovered, men have laboured to ascertain the physical conditions which favour and retard the propagation of these destructive parasites; and the result has shewn that here, as elsewhere, they should strive to help themselves, if they desire that heaven should help them.

(475.) "Mr. John Woolnough, of Boyton, sowed a large field, in alternate breadths, with wheat taken from a good sample, without dressing, and wheat that had been dressed in the usual manner. Long before the corn was ripe, the difference was most distinguishable. Upon those stretches sown with dressed wheat, it was difficult to find any branded ears; while the others were so branded as to make him determine to carry the corn at separate times to different places." [*Lin. Trans.* v.]

(476.) Other experiments shew that very careful washing with plain water is equally efficacious, though more troublesome than the use of more expensive means; but lime appears to have been found, on the whole, to afford the most manageable and least costly dressing for wheat. Mr. Bauer, who has performed many experiments on this subject, confirms the statements of other less scientific investigators. He gives it as his opinion that "lime-water destroys the vitality of the spores of both Uredo fœtida and Uredo segetum, and therefore he recommends seed-corn to be steeped in that solution." As the spores of the fungi are, however, often scattered in vast abundance over the soil before the

corn is reaped, and are there ready to infect the sound or prepared grain, it is also well to use lime as a manure, or, at any rate, to have a moderate quantity sprinkled over the fields, which, when dissolved by the rain, or washed into the soil, may destroy the spores of the Uredines which have been shed in the fields, as dressing the corn may free it from those which were carried with the grain.

(477.) The experiments of Sir Humphry Davy upon the nutritious properties of vegetables in various states, fully warrant the anxiety which farmers evince to keep their corn-fields free from blight and mildew, as these brands, or their effects, are usually called; for he has shewn that a thousand parts of good Middlesex wheat yield, on analysis, 955 parts of nutritious matter, and a thousand parts of spring wheat nearly as much, viz. 946 parts; while the same wheats, when blighted, yield from each thousand parts only 650 of nutritive matter, and, if much mildewed, only 210. So that, without calculating the injury to taste and colour, the absolutely nutritious portion is reduced to less than a quarter, nay, to little more than a fifth, of what is contained in healthy wheat.

(478.) The experiments of Fee upon the production of these minute parasitic fungi are extremely interesting, and, as running parallel with those of Bauer, must be considered quite satisfactory. Having collected some leaves of a Rosa centifolia, which were entirely covered with Uredo rubigo, he took three rose-trees of the same species, the leaves of which shewed no trace of Uredo, and, having put them in separate boxes, removed them from the neighbourhood of the affected plant, but still kept them in a similar aspect. One part of the rose-leaves covered with the Uredo was mixed, towards the end of the winter, with the mould in the box of one of the rose-trees, and the remainder subsequently used in the manner immediately to be detailed. When the second rose-tree was in full vigour, and near blossoming, some of the affected leaves were frequently shaken over the soil, to detach the seminules of the fungi, the remaining portion of which continued attached to the leaves. The branded rose-leaves were then steeped in water, and the third rose-tree watered with the mixture, during the whole of the spring. The three insulated plants exhibited nothing particular until the autumn: then the rose-tree in whose soil the brand-bearing leaves had been mixed became profusely covered

with the Uredo, the other two still remaining free; but the succeeding season the whole three plants were branded with myriads of Uredines.

(479.) The above experiments, Fee observes, appear to prove that the seminules of the fungi are absorbed by the radical fibres; that those which are mixed with soil, and become applied to the roots before the opening of the buds, are more readily absorbed and developed than after the leaves and flowers have been formed; as, in the two last instances in his experiments, they did not appear until early in the following spring.

(480.) The period in which fungi burst is often the period of their maturation, so that the wind carries their spores in clouds from place to place, and the rain precipitates them to the ground, and washes them into the soil. The viscidity of these spores, when wetted, serves to fix them to the root-fibres of the plants they subsequently grow upon, and of which they are sometimes supposed to be diseased formations, or equivocal descendants.

(481.) Nemasporaceæ. *Nemaspora*, the thread-brand, (from νημα and σπορα,) and *Stilbospora*, the brand-sheen, (from στιλβος and σπορα,) are the normal genera of two small groups, called by Fries *Nemasporei* and *Stilbosporei*, (*Nemasporidæ* and *Stilbosporidæ* of the present scheme of nomenclature.) These, together, form the type *Nemasporaeeæ*, which is easily distinguished from the preceding by the presence of a spurious stroma, to which the sporidia are attached. It is likewise well distinguished, both from the preceding and succeeding types, by all the genera it contains being found on dead, while the former are wholly, and the latter chiefly, parasitic on living plants.

(482.) Sporodesmiaceæ. *Sporodesmium*, the bond-blight, (from σπορα and δεςμὸς,) gives name to a small type, containing a few genera of not very important parasitic fungi, which are distinguished from the foregoing by the presence of a genuine receptacle, or stroma, to which the flocciform sporidia are attached. They are found on various plants, both living and dead; and hence would seem to form a connecting link between the two preceding types.

(483.) These three types, the *Uredinaceæ*, the *Nemasporaceæ*, and the *Sporodesmiaceæ*, collectively, form the section *Uredinæ*, the first, or lowest, in the order *Uredinales*, or *Mucedinales*. By Fries they have been called *Fungi entophyti*; and the chief diagnostic signs will be found to be, that the sporidia are either wholly

uncovered, and seated on the surface of the leaves of the plants on which they grow, or that they quickly become so by bursting through the cuticle by which at first they were covered and concealed. Hence, from this one portion of the group, the common name *Entophytes* was derived; which, however, although rightly descriptive of a part, is not truly applicable to the whole.

MUCEDINÆ.

(484.) Much difference of opinion has existed, and does still exist, amongst mycologists, as to the proper and systematic location of the genera included in this and the following section. To those who seek constantly for absolute divisions between the several groups of fungi, they will doubtless long remain stumbling-blocks; but to those who study the connexions of plants as essential means towards their natural distribution, these osculant tribes are always welcome links; although they are constant memorials of the imperfection of language, which does not allow us to express in definitions all the differences which our senses enable us to perceive.

(485.) Fusidiaceæ. In the first type of this section, the flocci, of which the receptacle is formed, are uniform, although varying in texture, some being rigid and persistent, others loose and evanescent; and upon these and other slight variations, further subdivisions have been attempted to be founded; but as the genera now known are few, and none of them of very commanding interest, the subordinate groups seem scarcely to be required, and therefore, as tending to complicate the study, they are not admitted here.

(486.) The *Fusidia* are found on the dead or dying leaves of the oak, beech, &c., and the other allied genera on other plants, as the Trifolia, while some luxuriate on rotten wood, dung, and similar matters.

(487.) Botrytiaceæ. *Botrytis*, the grapelet-mould, with its allies, *Penicillium* and *Aspergillus*, form the second type, which is known by the flocci being, for the most part, of two different forms and septate.

Aspergillus, lately separated from the old genus *Monilia* [§ 414], although connecting the *Byssaceæ* with the *Mucedinæ*, appears systematically rather to belong to this group than to the one in which Monilia is now arranged. Its history has, however, been already given when treating of Monilia, the genus in which it was formerly included.

(488.) The two types, *Botrytiaceæ* and *Fusidiaceæ*, when united, form the section *Mucedinæ;* the chief collective and distinctive characters of which group are derived from the sporidia being scattered over the flocci of the receptacle, and, although at first covered, quickly becoming free.

MUCORINÆ.

(489.) The MUCORINÆ have often, from an anatomical error, been arranged in the succeeding order, the TUBERALES or *Gasteromycetes*; but Fries has acutely distinguished between the inflated joint which, in the *Mucorinæ*, contains the *sporidia*, and the dense tunic formed by the interweaving of the flocci which forms the investment in the Tuberales: the latter having long been named *Peridium*, [§ 536-7:] the former, which bears some slight resemblance to it, is called the *Peridiolum*, [fig. *c*, *d*, *e*.]

Ascophora Mucedo.

(*a*) Natural size.

(*b*) Different stages of growth.

(*c*, *d*) Mature.

(*e*) Head, or peridiolum, artificially ruptured.

(*f*) ———————— collapsed.

(*g*) Sporidia.

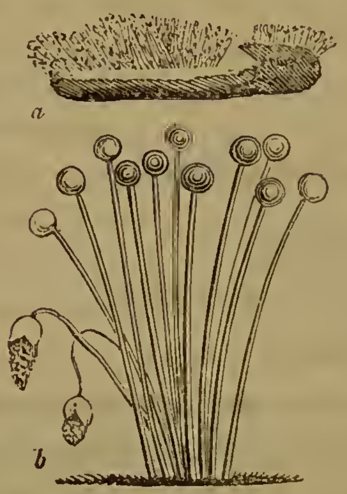
(*h*) Sporidiola, or spores.

(490.) ACREMONIACEÆ. *Acremonium*, the branching-mould, from *ακρεμων*, a branch, (the sporidia in this plant spring from the filaments as branches do from trees,) forms, with its allies, *Verticillium*, *Stachylidium*, and others, a small type called the *Acremoniaceæ*. The histories of these plants have not hitherto been sufficiently investigated to allow any facts to be recorded of them of special or peculiar interest. Their functions appear to be chiefly those which

are common to the whole order, and hence a short definition is all that will be required here. The chief distinctive characters of the type, as given by Fries, are " *Peridiola resembling sporidia, and affixed to the flocci* of the thallus, to the filaments of which, in some, the peridiola are adnate."

(491.) *Bactridium* and *Syzygites* have been separated from the other Acremoniaceæ by Fries, on account of their peridiola being tumid and adnate; if they are to be distinguished, it appears to be sufficient to form them into a subtype. However, even this seems to be scarcely wanting.

(492.) Mucoraceæ. *Mucor*, mildew, and *Eurotium*, mouldiness, both terms derived from Greek and Latin words, (ευρως and μυκης, or Mucor,) equivalent in their signification to the common English names of which they are synonymes, form, with their allies, *Ascophora*, *Thamnidium*, &c. the type *Mucoraceæ.*



Mucor caninus.

(*a*) Natural size.

(*b*) Magnified; the peridiola bursting, and discharging sporules.

These plants are very common on putrefying substances of various kinds, such as bread, meat, cheese, and fruit. The natural history of a part of these plants has been sedulously investigated; but a still larger portion seems to need much further research, and the special habitats and stations of the several genera and species require to be ascertained: for, from various accidents that have happened, and certain observations which have been made, it would seem probable that some of these parasitic fungi may afford indexes to the wholesome and deleterious states of many articles of food; in the same way as the lichens have been shewn to characterize various officinal barks, and to indicate their sound and worthless conditions.

(493.) Cases have frequently occurred, both in this country and

abroad, but they appear to have excited more attention in Paris than elsewhere, in which persons, after having eaten bread, meat, and other ordinary viands, have been seized with vomiting, purging, violent colicky pains, and other symptoms of having taken poison. Occasionally, suspicions of having administered poison have rested on those who had the charge, or had been engaged in the preparation of the food; but, on subjecting the suspected matters to chemical analysis, no trace of any deleterious substance has been found, *i. e.* no trace of any of the substances ordinarily considered poisons.

(494.) It has, however, long been known that animal and vegetable substances, which form, when sound, perfectly wholesome food, become, in certain stages of decomposition, highly deleterious; such especially is the case with corn, with wheaten and other flour, with meat, particularly pork, and many other articles in common use as food. Furthermore, the injurious qualities do not frequently hold a direct ratio with the degree of decomposition; but, even in the early stages of change, as in that of the human body, the hurtful principle is elaborated, and subsequently disappears; while, again, it sometimes happens that, at a later period, decaying organic bodies give out gases which are some of the most septic poisons the chemist knows of.

(495.) M. Chevallier, of Paris, has paid lately considerable attention to this subject, and has published several interesting memoirs relating to it. He expresses his conviction that cases of poisoning from this source are much more frequent than is generally supposed, and that they escape attention chiefly from the ignorance of the persons who mostly suffer. M. Chevallier, it appears, has noticed the deleterious change more frequently in pork than in other kinds of food, a very large quantity of which meat is consumed in Paris. He computes the annual consumption in that city alone at upwards of eight million pounds.

(496.) Numerous cases in point are recorded by M. Chevallier. Several occurred simultaneously in the family of a physician, whose wife, daughter, and servant were the sufferers. Another case happened in the practice of M. Brichetlau, who was sent for to attend a woman about forty years of age. She had been vomiting for several hours; her abdomen was excessively tender and her bowels much disordered; for, besides suffering extreme agony, she had, during the night, upwards of fifty evacuations. This malady was

traced to her having eaten some slices of bacon, purchased from a pork-butcher in the neighbourhood, for a young woman, who had taken a small morsel of the same meat, was similarly affected; and, on further inquiry, it was ascertained that a third person had been very ill who had eaten some pork purchased at the same time and place.

(497.) Several similar accidents having happened, official inquiries were instituted; and Drs. Durocher and Gœury, who were associated with M. Chevallier, reported that, although carefully analysed, no poisonous substances, such as arsenic, copper, &c., could be detected. But "the meat, a portion of which had occasioned the illness of a woman, was composed of several pieces cut from a lump of a preparation called *Italian cheese*, which is made of fragments of pork, &c., strongly seasoned, and converted into a kind of compact pie, that is usually sold in slices. The pieces examined were covered, some with blue and others with green mould; the latter giving the mass something of a coppery appearance:" and the report concludes by stating the conjoint opinion of all three, that the disorder was occasioned by the meat itself having undergone a partial decomposition. Dr. Paulus, of Saltz, has also placed on record seven cases of persons who were thus poisoned by eating Italian cheese, of whom three died; and various instances are known in which similar effects have followed the eating of ham pie, and other food, in which analogous alterations had taken place, and which seem to have been indicated by the fungi present.

(498.) Similar conclusions were arrived at by MM. Labarraque, Lecanu, and others, who have been engaged in similar inquiries; in one of these a pie had, in like manner, caused the serious illness of eight persons.

(499.) Bread made from flour undergoing decomposition has likewise been ascertained to be equally injurious. A case in point occurred about two years since at Hammersmith, in the family of the beadle of that hamlet. It is shortly as follows: The wife of the beadle bought in the morning a loaf, of which she ate a slice for her breakfast, and her son, twenty years of age, ate two slices toasted. Almost immediately after the meal both became unwell, with symptoms similar, but less severe, than those already in the other cases described. The loaf, when examined, was of a yellowish colour, and, although baked the same morning, it was sprinkled

with minute fungi, the greater part of which was black, or of a very dark colour; a few were green, and several yellow. The bread was soft, inelastic, and so tough that it could be drawn into strings; its taste and smell both were unpleasant.

Chemical analysis in this, as in the former cases, only afforded negative results. No recognisable poison, whether mineral or vegetable, could be traced; indeed, the absence of all known poisons was ascertained.

(500.) Some of the bread which had so much disordered both the woman and her son was then given to a dog, and some more to a cat, who were both similarly affected; and the evidence of the unwholesome state of the bread was thus rendered complete.

(501.) But a question arose as to whether the poisonous quality should be attributed to the bread, or to the fungi growing upon it. Further experiments proved that it was owing to some change in the bread, and not to the fungi, which are themselves innoxious; for a considerable quantity of the fungi, about five grains, having been collected, they were swallowed by a person, aged twenty-two, without any bad result; while a small bit of the bread, from which the fungi had been scraped, gave rise, when eaten, to colicky pains and tendency to diarrhœa.

Further evidence to the same effect was soon afterwards obtained. A quantity of dough was allowed to become mouldy in a damp place, and, when the mould was carefully removed, the dough was made into a small loaf, and baked. The loaf thus formed had precisely the same physical and poisonous properties as the Hammersmith bread, while the mould was eaten by a cat, a dog, and the experimentalist, with perfect impunity. On analysis, the bread was found to contain much less gluten than usual; the other proximate principles were in their ordinary proportions. [*Journ. de Chimie Médicale*, Dec. 1832, and *Lancet*, Feb. 1833.]

(502.) It is to be regretted that no botanical description has been given, in any of these cases, of the fungi growing on the deleterious food; and which not improbably will prove to be indices of the poisonous qualities of the substances on which they are found. It appears, from the slight notices of them, that they belong to the section now under consideration, and mostly to the present type, several genera of which are known to luxuriate on decomposing organic matters of various kinds.

(503.) The genera included in the type Mucoraceæ all agree in

having [§ 452,] "a distinct inflated peridiolum, growing from septate tubulose flocci; the sporidia also are distinct," [*Fries.*] These therefore become the distinctive and collective characters of the type.

(504.) Stilbiaceæ. *Stilbum*, the glaze-dew, (from στιλβος, shining,) is the normal genus of a very small and unimportant type, named, from it, the *Stilbiaceæ*.* These plants are distinguished by having "a thin and fugacious peridiolum, which is capituliform, confounded with the sporidia, and placed upon a continuous turgid stipes (stalk.)"

(505.) The three types *Stilbiaceæ*, *Mucoraceæ*, and *Acremoniaceæ*, form, collectively, the section *Mucorinæ*. The sporidia being free, and bursting through a simple, free, everted peridiolum, are the points in which these types agree, and, consequently, form the characters by which they are associated.

TUBERCULARINÆ.

(506.) Tuberculariaceæ. *Tubercularia*, the wart-mould, and *Fusarium*, the spindle-mould, form a small type, called, from the first or normal genus, the *Tuberculariaceæ*. In these plants "the receptacle is either roundish or flattened, at first innate, but afterwards free, being covered with the subdiffluent sporidia," (*Fries.*) The Tuberculariæ are common all the year on rotting sticks and the dead branches of trees; but they are much the most abundant in the autumn, when the T. confluens and granulata are added to the T. vulgaris. They spread over brush and fire-wood, and decaying sticks, in such profusion as to give them the appearance of having been sprinkled with red varnish, or thickly studded with small red beads.

(507.) Dermosporiaceæ. *Dermosporium*, and its allies, though closely connected with the former group, differ from the Tuberculariaceæ in having "a smooth, nearly spherical receptacle, seated superficially, freely evolved, and covered by the incumbent sporidia." None of these are plants of particular interest. The normal genus, of course, gives its name to the type.

(508.) Ceratiaceæ.† *Ceratium*, the horn-mould, with some few other genera, in which the receptacles, of various figures, are constructed of interwoven flocci, form the *Ceratiaceæ*, the third and

* Stilbini of Fries.

† Scoriadei and Cephalotrichei of Fries.

last type in this section. Certain genera, such as *Ceratium* and *Scorias*, have the receptacle more or less horizontally expanded, and they form the subtype *Scoriadæ;* while in the other remaining genera, such as *Cephalotrichum*, *Isaria*, &c., the receptacle is extended vertically and is club-shaped, either capitate, or branched. These form the subtype *Cephalotrichidæ;* of which Floccaria is a beautiful example.

Floccaria glauca. *Grev.*

(*a*) Group of plants, natural size, on a solution of gum arabic.

(*b*) Two plants, magnified, shewing the vertical clubshaped receptacle bearing sporidia on the flocci.

(*c*) Sporidia and filaments still further magnified.

(509.) The three types *Ceratiaceæ*, *Dermosporiaceæ*, and *Tuberculariaceæ*, associate to form the section *Tubercularinæ*; the chief collective and distinctive characters of which will be found to be the following. "Sporidia simple, attached to a solid persistent receptacle, either superficial, or liberated during growth."

(510.) Not any of the plants included in this section have the commanding interest of some of those described in the former, especially among the Uredinæ; still they all perform sedulously their parts in the general economy of nature, and labour, with their numerous associates, to disintegrate and dissolve the various dead and decaying organic bodies, some of which appear to be almost exclusively consigned to each. Probably, when their histories are more studied, and better known, the naturalist will find more abundant materials to enrich his records of these humble yet useful denizens, some of which are just on the confines of the vegetable world.

(511.) The sections *Uredinæ*, *Mucedinæ*, *Mucorinæ*, and *Tubercularinæ*, form, when associated, the order already named [§ 442,] MUCEDINALES. The naked sporidia, either always destitute of covering, or quickly becoming denuded, with the destitution of true peridium, perithecium, and hymenium, organs present in the other

orders, form the characters which associate these sections into a common group or order, and distinguish them from all other fungi.

(512.) The gradual development of special organs in the several grades of the lower fungi is inversely analogous to those evolutions of structure already traced in the lower Algæ. For, as in the flags, the thallus at first appeared, and was destitute of spores, so, on the contrary, in the fungi, the sporidia, in the most rudimentary stage, exist without a thallus. In Cylindrosporium they are even destitute of any covering, and in the Uredines an adventitious tunic alone is gained by the Entophytes elevating the cuticle of the plants on which they grow, and through which they burst. Subsequently, in Stilbospora, a spurious, and in Sporodermium, a true thallus (Stroma,) or receptacle, is formed, which in the Næmasporaceæ was in a very rudimentary state. In the Mucedinæ the receptacle becomes floccose, and, in the early stages of growth, the flocci cover the sporidia with which they are interspersed; and, in the Mucorinæ, the terminal cellules of the filaments become dilated, forming peridiola which contain the sporidia within them. These ventricose cells prefigure the peridia of the succeeding order; and the firm solid stroma which occurs in the Tubercularinæ may in like manner be esteemed an anticipation of the hardened nucleus found in that group of the Tuberales which some botanists hence have named the *Pyrenomycetes.*

The following tabular conspectus will serve as an index to the several types and sections contained in the order Mucedinales. The figures refer to the definitions of the several groups.

MUCEDINALES (511)	Tubercularinæ (509)	*Ceratiaceæ* (508)
		Dermosporiaceæ (507)
		Tuberculariaceæ (506)
	Mucorinæ (505)	*Stilbiaceæ* (504)
		Mucoraceæ (503)
		Acremoniaceæ (490)
	Mucedinæ (488)	*Botrytiaceæ* (487),
		Fusidiaceæ (485)
	Uredinæ (483)	*Sporodesmiaceæ* (482)
		Nemasporaceæ (481)
		Uredinaceæ (458)

TUBERALES.

(513.) The organs foreshadowed by the hardened receptacle, the fruit-bearing cellules, the interwoven flocci, and the false or adventitious tunics of the preceding groups, become fully developed in the several sections of the present order, and are distinguished by the names of *nucleus* and *asci*, *sporangia* and *perithecia*. Not that each organ is equally perfected in every group; for, in one, the nucleus, in another the floccose sporangia, and in another the asci, are predominantly evolved; and even the tunic, which is present in all, is sometimes double, and sometimes single; in some types free, in others connate, and in the lowest group of all so obscure as to be often considered obsolete.

(514.) The constant presence of the involving pouch, by which all the other organs are enclosed, renders it a most important associating character and diagnostic sign of the Tuberales; and, from its general ventricose form, these tuberiform fungi have sometimes been collectively called the *Gasteromycetes*. This name has, however, been used with such different significations, and employed to designate groups of such varied extent, that it has lost much of the precision which forms the chief value of a technical term. Thus by some it is given indifferently to all the ventricose fungi; while by others it is restrained to those only which have pouches without internal nuclei; and the nucleiferous Tuberales have been occasionally called *Pyrenomycetes*. But the distinctions here hinted at, as founded on the presence and absence of nuclei, although far from insignificant, when used as subordinate diagnoses, do not appear to be of such paramount importance, or universal application, as to compel a naturally allied order to be severed in two. Hence here the whole are included under the term *Tuberales*, a name derived from *Tuber*, the truffle, one of the most important and best known genera in the group.

SPHÆRINÆ.

(515.) Certain fungoid excrescences common on the leaves and other parts of plants, and named by Fungologists *Asteroma*, *Ectostroma*, &c., are many of them decidedly not distinct vegetables, but morbid growths: and others, although fungi, are fungi

the development of which has been arrested, and the sporidia not evolved. These essential organs being abortive, they are not admitted among the normal genera of the group, but form an appendix to the type *Xylomaceæ*, the first and lowest of the section *Sphærinæ*. Even in Xyloma, the typical genus, the sporidia are so obscure, that their presence has been sometimes doubted.

(516.) The *Asteromata* are minute barren fibrillæ, scattered over the deciduous parts of plants; the *Depazeæ* are minute dots on leaves; and the *Ectostromata* irregular spots, without any traces of fructification or regular organic structure.

(517.) *Xylomaceæ*. In *Xyloma*, the most rudimentary genus of this type and section, the pouch and nucleus are obsolete, so that it is chiefly distinguished by the negative character of the sporidia being *not* external and exposed, as in the preceding order. In the allied genera, *Leptostroma* (or thin scale-mould), *Actinothyrium* (or ray-pouch), *Lasiobotrys* (or wool-bunch), the nucleus and pouch (perithecium) become more and more distinct; but the sporidia, which are inclosed within the perithecium, are not collected in asci, but are free, resembling those attached to the flocci of the *Mucedinæ*. The nucleus, to which the sporidia are fixed in the above genera and their allies, is dry; and the perithecium ruptures irregularly: hence they have been associated to form the subtype *Xylomidæ*, which is thus distinguished from its co-ordinate *Cytisporidæ*; for, in the associated genera of this second subtype, the perithecium opens by a regular mouth (ostiolum), and the nucleus is soft and deliquescent. These two subtypes, each of which contains but very few genera, are allied by their sporidia being free, the cells in which those organs are contained in the subsequent types being obsolete, or very fugacious.

(518.) *Xyloma* is a fungus of such common occurrence, and in some of its species spreads so profusely, that it can hardly have escaped the notice even of the least observant. It is found on the Willow, Poplar, Beech, and many other plants, especially the Sycamore and Maple, the leaves of which are often so thickly covered by its broad black spots as entirely to change the aspect of the trees; giving them a mournful appearance, which sometimes but ill accords with the season, and with their associates of the forest or the fields.

(519.) *Cytispora* (the coffer-mould), with its allies, *Septoria*, *Sphæronema*, and others, which, together, form the subtype *Cytis-*

poridæ, are chiefly interesting as illustrations of progressive development; for, although the *asci* are not yet formed, they are anticipated by a thin fugacious cellule, in which the sporidia are, in the early stages, enclosed.

(520.) Phacidiaceæ. *Hysterium*, *Cliostomum*, *Dermea*, and *Patellaria*, are four genera which, with their respective allies, form four subtypes, called the *Hysteridæ*, *Cliostomidæ*, *Dermidæ*, and *Patellaridæ*. Associated, they constitute the type Phacidiaceæ, the second that occurs in the section Sphærinæ.

(521.) *Hysterium*, the penury-mould, so called from the wretched and miserable appearance of the plants on which this fungus abounds; *Phacidium*, the lentil-mould, and *Phytisma*, the wrinkle-mould, are the most important genera contained in the first subtype, the *Hysteridæ*, (Phacidei of Fries,) and consisting, especially the first, of the largest number of species. These plants are "subinnate, their perithecia subdimidiate, and, when they open, they expose a naked nucleus."

(522.) *Cliostomum*, and *Lophium*, with one or two other genera which Fries has distinguished as a subordinate group, the *Cliostomidæ* (or Cliostomei), differ from the foregoing by having their perithecia entire, adnate, and dehiscing by very straitened chinks. These fungi are likewise superficial.

(523.) *Dermea* and *Cenangium*, with the subgenera which the last-named genus includes, form the third subtype, *Cenangidæ*. These fungi are morphologically interesting, from the nuclei which bear the asci being in the shape of disks, somewhat resembling the *hymenia* of a higher order, and from having the disks supported by more or less distinct floccose strata, connate with the coriaceous perithecium; which strata may be compared to the receptacle of the Mycetales. The above characters, which associate the genera, will also serve sufficiently to distinguish the subtype.

(524.) *Patellaria*, and its allies, *Stegia* and *Tympanis*, form in like manner the last subtype. The perithecia in these plants are open and margined, but the opening is covered by a fine veil or operculum.

(525.) In all the preceding subtypes, which vary in slight subordinate particulars, it is found that the perithecia are dehiscent, and the discöid asci are erect and fixed. These therefore become

the characters which associate them into a common type, and distinguish the contingent groups.

(526.) *Sphæriaceæ.* This type, like both the preceding, has been distributed by Fries into several subordinate groups; and, although the analysis is thus carried often almost to the verge of excess, it is difficult to avoid submission to such distinguished authority.

(527.) The genera *Dothidea*, *Strigula*, *Dichæna*, and *Sphæria*, are illustrations of those subtypes to which they give their respective names.

(528.) The *Dothidæ* are innate epiphytes, with the ostiola, when present, minute and like a pore.

(529.) The *Strigulidæ*, which have hitherto been noticed only on the leaves of tropical plants, have the ostiola unequal, often large, the stromata double; and subsequently becoming a horny crust.

(530.) The *Dichænidæ* have ostiola not prominent, but perithecia dehiscing by chinks. The stromata are discrete and adnate. These fungi grow both on dead and living plants.

(531.) The *Sphæridæ* have their ostiola regular, more or less predominant, generally round, rarely compressed. These fungi grow on various dead or scarcely living organic substances. Sphæria is a very extensive, and doubtless, an important genus, as assisting in the destruction and removal of dead and offensive organic matters. The annals of these plants are, however, scanty, and the records few, of their immediate utility to man. The indirect services they perform are evident to all.

(532.) The three types, *Xylomaceæ*, *Phacidiaceæ*, and *Sphæriaceæ*, which differ from each other by having their ascigerous nuclei moist or dry, and, when the asci are obliterated, the sporidia being fixed to the nuclei, agree in having their perithecia (which are cases enclosing the fruit-bearing nuclei), either perforated by ostiola, or irregularly dehiscent. The structure of these plants is obscurely cellular, and the stromata subfilamentous. Collectively, these types form the section *Sphærinæ*, of which the preceding characters are distinctive signs. In this section are included all those fungi which botanists, who use the term, call Pyrenomycetes.

(533.) In recording the names of such numerous genera, types and sections, including multitudes of species of these lower fungi,

a kind of disappointment is felt, that, of so many tribes, our ignorance allows so little to be said; that, while their structures have been examined, and myriads of species, which were once confounded and confusedly crowded into a single order, are now shewn to constitute an extensive class, distributable into groups, as distinct and as numerous, as the acknowledged orders of larger and less retiring plants; that so little should have been discovered of the final causes of their variety, as well as of their abundance; that vegetables of such exquisite formation, and of such astonishing variety, should not have each a tale to tell, of interest equal to their beauty. We feel dissatisfied that our notices should so often be confined to the bare statement that *they are*, and that all we know of their utilities is their general uses; duties which are performed by all the class in common, which, however, may be far more important than the particular purposes to which certain specific individuals are applied.

Doubtless, our ignorance veils much that is curious, very much that is important in the histories of these plants, which will hereafter be revealed; still, though little has been learned, enough even now is known, for us to join in the elegant apostrophe of Linnæus to the greatness of such minute wonders of creation. "Legi aliquot Dei vestigia per creata rerum, in quibus omnibus, etiam in minimis, ut fere nullis, quæ vis! quanta sapienta! quam inextricabilis perfectio!"

BOVISTINÆ.

(534.) The genera included in this section are very numerous, but the species contained in each genus few. This circumstance may, perhaps, be accounted for by the little tendency that these plants have to vary from their regular forms; which varieties, when they become permanent, it is often difficult to distinguish from original species; and hence they are specifically named and classed as such in all systematic works. But, though little subject to vary from their normal structure, there are none that exhibit more marked transitional developments, which, as Fries observes, may be compared to the noted metamorphoses of insects: the *Physaridæ*, and *Trichiadæ*, especially afford extraordinary instances of these regular transitions; indeed, one species of *Trichia* has hence been called the *many-shaped (polymorpha)*; a plant well known, at least

by name, from its having been discovered by the late Mr. Sowerby, in a very unlooked-for situation; *i. e.* in a place that is not often included in a botanical excursion, viz. at the top of the cathedral of St. Paul.

(535.) Many of the fungi contained in this class are meteoric, and, like other meteoric plants, they occur most abundantly during one season, in places where scarcely a single plant can be found in others. In their early stages of growth most of them are soft, and often slimy; but afterwards the majority become dry, like tinder or touchwood. The bulk of each fungus is formed of interwoven tufts of filaments (flocci,) interspersed with numerous sporidia, but not contained in *asci*, as in the previous section; from which the Bovistinæ (or Gasteromycetes) are further distinguished by the absence of a nucleus, an essential characteristic of the Sphærinæ (or Pyrenomycetes.) The mass of flocci is collectively called a *sporangium*; and the tunic which invests it a *peridium*. The peridium differs from the perithecium only in the adventitious circumstance of its covering a *sporangium*, and not including a nucleus. When a fungus, as is the case in the Truffle [§ 595,] appears to be compound, and to contain many smaller ones within it, the whole is called a *sporangium*, and the lesser portions *sporangiola;* their including membranes, analogous to the tumid cells of the Mucorinæ, are, like them, denominated *peridiola*.

(536.) In size the Bovistinæ vary more than do the species contained in any other section. Indeed, they nearly approach the extremes of bulk hitherto observed, the *Erysiphidæ* being among the smallest, and the *Bovistinæ* (for example, the huge Bovista gigantea,) amongst the largest fungi known. In form likewise they are not less remarkable, for the Phalli and Clathri are some of the most extraordinary vegetables in existence.

(537.) Sclerotiaceæ. *Erysiphe*, the round-mould, *Sclerotium*, the hard-mould, and *Rhizoctonia*, the death-mould, are the normal genera of the three subtypes, *Erysiphidæ*, *Sclerotidæ*, and *Rhizoctonidæ*, included in the type Sclerotiaceæ.

(538.) *Erysiphidæ*. *Erysiphe*, or *Erysibe*, is an old Greek name for mildew, and many of the species of the modern genus are popularly known as moulds, or mildews: they infest especially living vegetables, and are commonly found upon the leaves of the pea, clover, berbery, and many other plants, either scattered over

the surface like powder, or collected into spots and patches. The names of the different species are, in general, derived from the different vegetables on which they grow.

A. Erysiphe adunca.

(*a*) Numerous plants on a willow leaf.
(*b*) One plant detached.
(*c*) Peridium bursting from excess of moisture.
(*d*) Sporangiola.
(*e*) Filament magnified.

B. Erysiphe Pisi.

(*f*) Groups of plants on a pea-leaf, natural size.
(*g*, *g*, *h*) Plants detached, and more or less magnified; one sporangium bursting.
(*i*) Sporangiola inclosing the sporidia.

In *Erysiphe*, and its associates, *Perisporium*, *Lasiobotrys*, &c., which compose the subtype *Erysiphidæ*, the peridia, which are confused and blended with the sporangia, include sporangiola. They are also epiphytic on living plants.

(539.) *Sclerotidæ*. *Sclerotium*, and its allies, *Periola*, *Acrospermum*, and *Sphacelia*, or *Acinula*, differ from the *Erysiphidæ*, by having the peridia, which, as in them, is confused and almost obliterated, always closed. Internally it is obscurely vesicular and sporidiferous; the spores at length emerging, but not by any regular dehiscence. Some of these are most destructive fungi, being parasitic not only on dead, but on living vegetables, which will distinguish them from some of the following group, part of which are superficially attached to dead vegetable matter, while the rest are parasitic on plants that are alive. The *Periolæ* infest the roots of potatoes, and other plants; and the *Acrosperma* are found on putrid fungi of larger kinds, as well as on dead herbaceous plants.

(540.) *Acinula*, or *Sphacelia*, is, however, the most important genus in the group. It used to be considered a species of *Sclerotium*, but it is easily distinguished by its diffluent peridium being spread over a berry-like, club-shaped sporangium; whence its name, *Acinula Clavus*. The synonyme *Sphacelia Segetum* has reference to the gangrenous diseases with which animals become affected who are fed on spurred grain, as corn is called when bearing this fungus.

Secale Cornutum.

D. A healthy ear of rye.

(*a*, *b*) Culm and spike.

E. Figure of a similar ear of spurred rye.

(*a*) Culm.

(*b*, *c*) Ear with natural spikelets, and also with others affected with the ergot.

(*d*) A spikelet, separated to shew the fungus on the ovary or young grain.

(*e*) The awns.

(*f*) The husks.

(*h*, *g*) Two entire and full-grown samples.

(*i*) The ovary magnified with the spur in an early stage.

(*k*) A section to shew the sporidia.

(*l*) The sporules.

(541.) By some persons the ergot, or spur, is considered to be a *disease* of the grain, occurring spontaneously; others think that it is an unnatural condition, produced by the puncture of insects. Both these opinions have been attempted to be supported by direct experiment. Willdenow states that he could produce the ergot at pleasure in rye, by excessive watering; while General Martin Field, who had observed flies puncture the ears of rye during their milky state, imitated the process by wounding them with a needle. In both cases he found the juice exude, and in four days a small black point was visible, which he affirms subsequently became a spur. Fontana, on the contrary, states that the ergot may be propagated from plant to plant, and even that he has expressly transmitted it by contact from ear to ear. Hertwig, however, in repeating Fontana's experiments, arrived at a different result. But this matter is now set at rest; for De Candolle, and others, have

determined the ergot to be a distinct parasitic plant, which locates itself in the ovary of many of the grasses. The seeds and seed-vessels affected, instead of becoming normally developed, are perverted in an early stage of their growth, and a lengthened club-shaped body protrudes from the husks in place of the grain. From this peculiarity of form it has received the specific name *clavus*. Hence also may be traced the origin of its more common appellations *ergot* and *horned*, or *spurred* grain, from its resemblance to horns, or cockspurs.

(542.) Rye is more frequently and commonly attacked by this fungus than any other grass: hence the *ergot of Rye*, the *horned* or *spurred Rye*, the *siegle ergoté*, or *secale cornutum*, of medicine, will form the most familiar example. But, although the most common, rye is not the only habitat; for the ergot has been found on wheat, oats, maize, and barley, among the *Cerealia;* and upon many of the fodder-grasses, as, for example, *Alopecurus pratensis*, *Lolium perenne*, *Holcus avenaceus* and *lanatus*, *Aira cristata*, *Agrostis stolonifera*, &c.

(543.) The presence of this fungus alters in a most important manner the qualities and properties of the grain on which it is found; not only, like the uredo, diminishing the proportion of nutritive matter, but converting a wholesome grain into a hurtful food, and even a fearful poison. Like many other poisons, however, the ergot forms, when duly administered, a valuable medicine; being peculiarly serviceable in one of the most interesting and hazardous conditions to which women are subject: for, without exaggerating its virtues, it may be fairly said that the discovery of this little fungus has added a new article to our scanty list of heroic, or specific remedies.

(544.) Corn is much less subject to be affected with ergot in this country than in France; and, as we grow much less *rye* than many of our continental neighbours, the *Secale cornutum* has been occasionally scarce, which has led to a variety of frauds. Some specimens, which were procured for analysis by a celebrated chemist, were found to be only plaster of Paris casts coloured in imitation of the ergot. No wonder, when such fictitious samples are in the market, that great discrepancies should occur in reports of the specific powers of this extraordinary substance, which, even in its natural state, is liable to be rendered more or less potent by the influence of external physical causes. For example: as it has

been ascertained that, in the bitter almond, the prussic acid is chiefly, if not wholly, confined to the testa of the seed, so, in the ergot, the active principle resides in the diffluent peridium, [§ 540]; hence if heavy rains fall at the time the peridium is soft and moist, it will be washed away, and the hardened club-like nucleus, if wholly denuded, will be utterly inert. But, if the weather be fine during the maturation of the fungus, the diffluent peridium will be dried upon the spur, and the ergot be in its most active state. Hence, for medicinal purposes, and also when spurred grain is to be used as food, especial regard should be had to the above circumstances.

(545.) The disease referred to, as following the long-continued use of spurred rye for food, is that most extraordinary affection, the *dry gangrene;* which becomes, occasionally, an endemic, and even an epidemic scourge.

M. Dodard first called the attention of the public to this disease, in the year 1676. He says "it had been long known that persons who ate rye bread made with corrupted grain were liable to be affected with gangrene in their extremities, attended usually with little fever, inflammation, or pain; but, during the progress of which, the use of the limbs affected was lost, or the limb itself died, and separated from the body. The parts at first became insensible and cold; and, in the progress of the disorder, dry, hard, and withered. In very malignant cases, Dodard says that delirium occurred; and he also mentions, that the grain proved fatal to fowls that fed upon it."

(546.) Saviard relates various cases which he witnessed in 1694, and for which he was obliged to perform some original operations. He says "that the disease is very frequent in Sologne; that it attacks those who eat rye affected with the cockspur; and that the upper and lower extremities of the patients he saw grew, during the course of the disorder, as dry as touchwood, and as emaciated as those of Egyptian mummies."

According to the severity of the attack, greater or less portions of the limbs are destroyed; of thirty patients, seen by M. Noel in one season (1710) in the Hotel Dieu of Orleans, some lost only their toes, others their feet at the ankle-joints, others the whole of their legs; and, in one case, communicated to the Academy of Medicine, the lower extremities separated from the trunk at the hip-joints; the heads of the thigh-bones disarticulating from the *Acetabula*. This lamentable occurrence is reported to have first suggested that important surgical operation, amputation at the hip-joint; for granulations formed, and the sufferer recovered, even after such a fearful dismemberment of the body.

During the thirty-three years that the M. Noel abovementioned was surgeon of the Hotel Dieu, at Orleans, this disease was endemic four times. Little relief save amputation could be afforded to the patients, for they seldom applied until the noxious grain had worked its worst. The symptoms in all appear to have been nearly the same, "the part affected becoming black like a piece of charcoal, and as dry as if it had been passed through the fire." The fatality of the complaints appears to have been very various, for sometimes the majority recovered with the loss of one or more limbs, while at others, as in the endemic of 1748,

M. Duhamel reports, that of 120 persons attacked, scarcely *four* or five escaped with their lives. Languis also states that it was equally fatal in Switzerland.

(547.) A calamity so serious, and recurring so often, could not fail to attract public attention, and stimulate the curiosity of medical men; and, accordingly, we find that, in France, many attempts were made to discover the true source from which it proceeded. In attending to this subject, it was soon discovered that *animals of every kind, except man*, refused, in general, to eat rye affected with the cockspur; and that many of them would rather starve, than taste bread or food of any kind into which a portion of it had, for experiment, been introduced. Those animals which were found or forced to swallow it were observed to die of gangrene, which, in different individuals, attacked different parts of their bodies.

(548.) When the spurred grain bears only a small proportion to that which is sound, the blended corn may be eaten with impunity. Thus, in countries where the ergot prevails, the harvests of ordinary years, though seldom, if ever, wholly free, afford food which may be eaten without notable injury. But when a wet spring or summer occurs, by which the growth of the fungi is favored, and the grain becomes affected to the amount, as often happens, of one fourth or one third of the gross product, then it is that the endemic rages. Some persons seem to be peculiarly susceptible of its influence, and others impregnable to its baneful effects. This may be often owing to peculiarities of constitution; but the apparent paradox, that grain, in which the spur prevails in equal proportions, will in some years produce this loathsome disease, and in others be wholly inert, can be only explained by the observation of Seveillé, before alluded to, viz. that the active principle resides chiefly, if not entirely, in the diffluent peridium, which may be, and often is, washed off, if heavy rains fall during the ripening of the fungi; for, although moisture favors their early growth in spring and summer, it is a dry autumn which insures their activity.

(549.) This occasional impunity led some persons to doubt the deleterious properties of ergot. M. Tessier, however, clearly proved, that in those seasons only in which the spurred rye was very abundant, did the epidemic gangrene appear; and he instituted experiments upon animals, which completely established its poisonous qualities. He also found, as others had before him, that animals have a strong aversion to spurred corn, either alone, or mixed with the substances on which they usually feed. Hence it became extremely difficult to disguise the diseased rye, so as to induce animals to swallow, voluntarily, any portion of food into which it had been introduced. He succeeded in administering it to two ducks, two pigs, and a turkey. They all perished after a certain length of time. The duck, drake, and turkey, in nine, fourteen, and twenty-two days respectively. In all, the extremities of the body suffered most, becoming pale, yellow, emaciated, and ultimately gangrenous. Dr. Robert further observes, that dogs and cats, in consequence of discharging the ergot by vomiting, suffer only slight symptoms of irritant poisoning; but that swine, moles, geese, ducks, fowls, quails, sparrows, as well as leeches and flies, are sooner or later killed by it; and that the symptoms it causes in beasts and birds, are, in the first instance, giddiness, dilated pupil, and palsy; and afterwards, diarrhœa, suppurating tumours, scattered gangrene throughout the body, and sometimes dropping off of the toes.

(550.) Sologne, where this malady most frequently occurs, is a district which

appears, from its physical conditions, to be most peculiarly fitted for the production of the ergot. It is situated between the rivers Loire and Cher; the soil is poor, chiefly clayey, or clay-bound, and very wet; so wet, that the corn is obliged to be sown on the *tops of furrows a foot high;* and so poor, that, although it is suffered to lie fallow every third season, it is exhausted at the end of ten or twelve years at farthest, and the farmers are compelled to let it remain a long while in the state of pasture, before it will again bear corn.

In this district it therefore was that the Abbé Tessier, who was deputed by the French Academy to examine more particularly the circumstances attending this disease, made his observations. Of these Dr. John Thompson has availed himself in the compilation of his valuable essay, the most important parts of which have been condensed and combined, with the researches of others, in this history of the plant now under consideration.

(551.) Rye is so little cultivated now in England, that, although the ergot does occasionally appear, when wet seasons and wet poor soils favor its development, still it never occurs in sufficient abundance to produce the calamitous effects recorded by the French physicians. But wheat, and other grain, is obnoxious to the same, or similar attacks; and it is not improbable that many of the epidemics of former times, and even of the present age, may originate from such a cause. A case immediately in point is recorded in the Philosophical Transactions for the year 1762. It is narrated by a Dr. Wollaston; but the previous history is given by the Rev. Mr. Bone, the curate of the parish. From these accounts, it appears that a farmer, in the village of Wallisham, about sixteen miles from Bury St. Edmund's, in Suffolk, had some of his wheat laid by bad weather, and, that it might not spoil his samples, he had it gathered and threshed separately. This diseased or damaged wheat was threshed at Christmas, and was sold at a low price to several of the labourers on the farm, and other poor persons in the village. One family, consisting of a man, his wife, and six children, eat no other bread than what was made from this wheat for a considerable time: they were accustomed to buy two bushels of this clog-wheat or rivets, or bearded wheat, (as it is variously called in the country,) every fortnight; and, although it made bad bread, and worse puddings, they still persisted in its use until they were all attacked with gangrenous ergotism. The mother and six children fell ill within a few days of each other. The earliest symptoms, which were intense pains in the lower extremities, were first felt on the 10th of January; these, however, subsided in a few days, and then succeeded the mortification.

The following was the state of this miserable family, at the time that Dr. Wollaston's report was drawn up and sent to the Royal Society:

"*Mary, the mother, aged forty.* Right foot off at the ankle; left leg mortified, a mere bone, but not off.

"*Elizabeth, aged thirteen.* Both legs off below the knees.

"*Sarah, aged ten.* One foot off at the ankle.

"*Robert, aged eight.* Both legs off below the knees.

"*Edward, aged four.* Both feet off at the ankles.

"*An infant, aged four months.* Dead.

"*The father* was not attacked till about a fortnight after his wife and children, and in a slighter degree. In him the pain was confined to two fingers of his right hand, which turned blackish, and withered. Another labouring man in the same

parish, who had eaten of this bread, suffered from numbness in both his hands, for above a month. They were constantly cold, and his finger-ends peeled; one thumb, he says, still remains without any sensation."

Some of this corn was made into bread, and eaten in the farmer's family, and also by various other persons; but, as none of them experienced any ill effects, it is to be presumed that the quantity eaten by them was much less, or in much less proportion to other more wholesome food.

(552.) The *dry gangrene,* above described, is called *gangrenous ergotism* by the French, who mention another form of the disease, which they name *convulsive ergotism.* So different, however, are the symptoms which characterize these two maladies, that I cannot but agree with Dr. Watson, in 'suspecting that their causes must be different too.' For, instead of the characteristic symptoms of gangrenous ergotism, viz. great discomfort or *malaise,* nausea, languor, fainting, vomiting, with a sense of tingling or formication preceding the coldness and numbness, of the toes and lower extremities, which subsequently wither, dry, become black as if burned, and, lastly, drop off at the joints; the convulsive ergotism is chiefly marked by giddiness, spasms, convulsions, and painful contractions of the limbs, no mention being made of gangrene; and the symptoms recorded agree with Cullen's definition of Raphania. "*Articulorum contractio spastica, cum agitatione convulsivâ, dolore violentissimo, periodico.*"

(553.) These two forms of disease are seldom intermixed with each other. Of twenty-nine epidemics, accounts of which were collected by Ozanam, nineteen were of the convulsive, and ten of the gangrenous kind. Other instances have however been mentioned, in which the two sets of symptoms have been mixed. Dr. Frank, for example, has given an account of a disease, occuring in Germany, which forms a link between the Raphania or convulsive ergotism, described by the Swedish, and the gangrenous ergotism of the French writers. Convulsions were the prominent symptoms in Dr. Frank's cases; but these were almost uniformly followed by an erythematic inflammation of the limbs, and sometimes gangrene of the fingers and toes.

Some writers of the present day have hence supposed that the use of the spurred corn in a certain dose or proportion, gives rise to the convulsive affection, and that the habitual consumption of a larger proportion, or even a more protracted use of a smaller, determines the supervention of gangrene; so that the symptoms, distinct as they are in the two cases from each other, mark different stages merely, or different degrees, of the same malady.

(554.) The *Raphania* has been clearly traced in Sweden to the admixture of the seeds of the *Raphanus, Raphanistrum,* with ordinary bread-corn. In the sixth volume of the Amœnitates Academicæ, there is a treatise on the subject, by Rothman, in which the disease was traced to the R. Raphanistrum by a curious but very satisfactory process of induction.

In the first place, the author traces the disease to the use of some corn; shewing, that children who live entirely on milk never have it.

Secondly, he proves, by a similar mode of exclusion, that it is owing to the use of barley, and not of rye.

Thirdly, that it proceeds from the use of such corn sown in the spring.

Fourthly, that there is no diseased appearance observable in the grain itself, but that two seeds are found mixed with it, in those places where the disease occurs,

and not in the other parts of the country. These are the seeds of the wild cabbage (Brassica campestris), and of the charlock (Raphanus Raphanistrum.)

He then argues that the former of these is not the cause of the complaint, for it is found mixed with the rye also; he shews likewise that the disease was most prevalent after wet seasons, in which the Raphanus had grown most abundantly and luxuriantly: and, furthermore, an experiment made on an animal confirmed his opinion.

(555.) Curious and conclusive as these reasonings and observations are, as far as they go, it is probable that the chain is not quite complete; for although the cause of Raphania has been traced to the Raphanus, in the same way as gangrenous ergotism to the rye, it is unlikely that it proceeds from the consumption of the charlock seeds in a healthy state. The state of the charlock seeds should have been examined; for, if it be not owing to a morbid condition of the seed, or to the presence of some parasite analogous to the ergot, it would be difficult to account for Raphania not appearing every year, as the Raphanus is constantly and abundantly blended with the corn, both in Sweden and in this country. In England, however, Raphania is unknown.

(556.) This belief has persuaded me to quote the preceding account of *Raphania;* not so much for the sake of expressing an opinion as to the real origin of the disease, as to record my conviction, which is supported by good authority, that other epidemic and endemic maladies might be traced to similar causes. As I have before said, the history of the fungi has been as yet far too little studied; of their habits and properties there is far too little known. However, from what has already been discovered, we know that they perform a most important part in the general economy of nature; and it is not unreasonable to believe, that their influence extends much farther than it has hitherto been traced.

(557.) Periodical and endemic diseases spring up, from time to time, in various places, of which the origin is involved in much obscurity. It is not unlikely, observes Dr. Watson, that they may depend upon some accidental cause analogous to that which gives rise to the ergotic gangrene. As a recent instance of such an endemic complaint, the cause of which has hitherto escaped observation, reference may be made to that remarkable distemper which began about four years ago in Paris, for the first time that it had been observed at all, and which, for several months during the spring and autumn, for two years in succession, affected a very large proportion of the population of that city. Its prominent and characteristic symptom, according to Andral, was pain of a peculiar kind, and often extremely severe in degree, in the hands and feet, and sometimes in other parts. From this, its principal feature, the complaint has been called *acrodynia.* After some time the

pain diminished, but the sensibility of the skin was found to be impaired, and the part was numb. Other symptoms supervened. The skin of the hands and feet often became red, and the cuticle then separated in large flakes; or large vesicles formed. In some cases the epidermis came off entire, retaining the form of the hand or foot, like a glove or sock. The skin frequently also became brown or black. Although no instances are recorded in which this epidemic proved fatal, yet it caused a great deal of suffering, and prevented numerous poor persons for a very long time from performing their labours.

(558.) Some of the symptoms of this singular disease are closely analogous to those which follow the use of spurred rye; and, occurring as it did, at a particular period each year, over a limited space, and chiefly, though not exclusively, in the crowded parts of the city, and amongst the lower classes of the people, the most probable solution that presents itself is, that it was caused by the use of some common article of diet, which had accidentally become depraved, or infected with an unwholesome quality.

(559.) Whether the *Italian cheese*, which has been already shewn to become, under certain circumstances, not only unwholesome, but poisonous, may, if eaten in small quantities, or in a less corrupted state, for a greater length of time, produce the symptoms above detailed, remains to be proved. The case, however, if so, would only be parallel to the two forms of ergotism before described, which are believed, by many physicians, to be attributable to such differences of administration.

(560.) In truth, the operation of this species of cause, in producing endemic and epidemic diseases, has already been traced in various parts of the world, although the subject has not received that full share of investigation which its manifest importance demands. The use of unsound maize has been known to produce, in some parts of America, very serious consequences. The degenerate corn is there known by the name of *mais peladero*. When it is eaten in considerable quantity, or for some time together, it is said to occasion the hair to fall off, and the teeth to become loose; but it causes neither convulsions nor gangrene. Fowls fed upon it lay eggs without shells. In some animals, in apes and parrots, for example, and in dogs and deer, it produces, when eaten, a kind of intoxication; and when taken more largely, it proves fatal. When swine eat it, which after a time they do with avidity, their bristles drop off, and their hind legs become feeble and wasted. Mules likewise lose their hair, and their hoofs swell. Now it is very curious, and not less important than curious, that, in the provinces of Neyba and Maraquito, in Colombia, where these extraordinary phenomena have been observed, the maize is very subject to the spur. This we learn from the investigations of M. Roullin, who, in tracing the abovenamed diseases to their cause, found a species of ergot to be very common, which converted the roundish grains into black pear-shaped bodies, not very unlike the spurs in European rye.

(561.) To conclude this subject, it may be observed, Dr. Willan held, that the "Morbus Hungarius, and some other diseases, reputed pestilential, might be added to the list of epidemics produced by ergot, or by a similar affection or degeneration of other grain." The sweating sickness, which occurred more than once in England in the beginning of the sixteenth century, was perhaps owing to some disease or depravation in the wheat, or to some noxious vegetable growing with it in

particular situations; for, although the disease extended itself chiefly over the northern counties, it neither affected the inhabitants of Wales nor of Scotland, who did not at that period eat wheaten bread. It was remarked by Schiller, (in his Treatise de Peste Britannicâ,) that birds at that time fell dead everywhere from off the trees, with small abscesses under their wings. This he refers to a poisonous quality in the air: but was not the effect (asks Dr. Willan) more probably produced by damaged grain taken as food, according to the result of the Abbé Tessier's and Dr. Roberts's experiments? [see § 549.]

(552.) *Rhizoctonidæ.* The last subtype included in the type Sclerotiaceæ contains *Rhizoctonia* and *Apiosporium*, among other less known and less important genera. The *Rhizoctonidæ* are distinguished from the other subtypes with which they are associated by having their peridia freely evolved, although connate with the sporangia. In some of the genera, such as *Apiosporium*, the sporidia are immersed and collected in the centre of the sporangium: whence Fries would form of them a group (*Apiosporidæ*), distinct from the true *Rhizoctonidæ*, in which there is no such central aggregation of the sporidia, and in which indeed the fructification is often obsolete. Such slight differences, however, do not seem to warrant the division, although the habits of Rhizoctonia and its nearest associates are peculiar, being chiefly subterranean fungi, parasitic on the root-fibres of other plants.

(553.) *Rhizoctonia*, as it has been named by De Candolle, is the *Thanatophytum*, or death-mould, of Nees. Both terms are peculiarly expressive of the destructive powers of the plant. It is found on the roots of the cultivated saffron; and so rapidly does it spread over whole fields, exterminating entire and extensive crops, that it is familiarly known to the French as '*la mort du safran.*' Its ravages are with the most certainty arrested by cutting a trench twelve or eighteen inches deep between the diseased and healthy tracts. This mode of staying the progress of the plague deserves especial attention, as it shews that, although so rapid in its march, its course must be subterranean; for, did the spores rise to the surface of the earth, to be carried by the winds from place to place, the trench would prove an ineffectual barrier, instead of the certain protection that it is known to be, when cut early and deep enough. The minute spores of these, and other subterranean fungi, are most probably conveyed from one situation to another, by the water which percolates the soil. That they are abundant in the ground of infected places, is proved by the fact, that the smallest quantity of earth, from an infected field, will ensure the propaga-

tion of the fungi; and, as it is said, even if the ground be not planted with saffron for twenty years afterwards. Smith states that this destructive parasitie has not been heard of hitherto any where but in France. The plague are of an irregular knobbed figure, from half an inch to an inch long, of a light reddish brown colour. Long capillary roots, or offsets, are sent out in every direction, which propagate the plague very extensively and readily. They attach themselves to the saffron, and, multiplying within the substance of the bulbs, soon destroy them.

(564.) These three subtypes, *Rhizoctonidæ*, *Sclerotidæ*, and *Erysiphidæ*, form, when associated, the type *Sclerotiaceæ;* the collective and distinctive characters of which are the following: Peridia contiguous to, and either connate, or confounded with the persistent sporangia. Sporidia more or less abortive, never pulverulent.

(565.) Spumariaceæ. *Trichoderma*, *Onygena*, *Hyphelia*, and *Spumaria*, all curious and interesting, but not very important plants, give names, respectively, to four subtypes, included in the type *Spumariaceæ*. Collectively they are known by their spurious peridia being either membrano-cellular, or formed by flocci loosely interwoven; these *peridia* are fugacious, of an indeterminate figure, and the naked sporidia they enclose are crowded together, being rarely intermixed with flocci.

(566.) In the *Trichodermidæ* the peridium is sessile, roundish, floccose, or scaly and floccose; evanescent in the middle. Internal flocci none; sporidia compact and conglobate; thallus none.

(567.) In the *Onygenidæ* the peridium is generally subglobose, (yet the figure varies;) at first fleshy, afterwards flocculent and scaly. Internal flocci none; sporidia compact; thallus forming a stalk.

(568.) In the *Hyphelidæ* the peridium is sessile, subeffuse, indeterminate, formed of interwoven flocci, rarely smooth, fugacious. Sporidia crowded; and not intermixed with flocci.

(569.) In the *Spumaridæ*, which, like the previous subtype, have the peridia sessile, subeffuse, and indeterminate, these organs are very fragile, formed of cells, and sometimes covered externally with flocci. At first, the peridium in these plants is mucilaginous, subsequently evanescent. The sporidia are crowded, but intermixed with flocci.

(570.) *Onygena* is a curious fungus, only as yet found on horses' hoofs. *Spumaria* is perhaps the most familiar genus in the type, as, in the autumn, it is commonly spread over the leaves and branches both of dead and living plants, and has the appearance of frozen scum or froth.

(571.) BOVISTACEÆ. *Trichia* (the hair-mould), *Physarum* (the blister-mould), *Bovista* (the puff-ball), and *Scleroderma* (the hard-ball), are the normal genera of four subtypes, which, together, form the BOVISTACEÆ. Their most obvious distinctions depend upon their different degrees of firmness and solidity.

(572.) In the *Trichiadæ*, "the peridium is simple, and more or less fugacious; at first being *mucilaginous*, and subsequently becoming *membranaceous*. The sporidia are either scattered over distinct filaments, or collected together into tufts."

These are minute plants, chiefly found on the trunks of old trees and on decaying wood. Their forms are very various and beautiful. Some of them resemble the stamina of flowering plants, and others assume the forms of nets and sieves; whence indeed their names, *Stemonitis*, *Dyctidium*, *Cribaria*, &c.

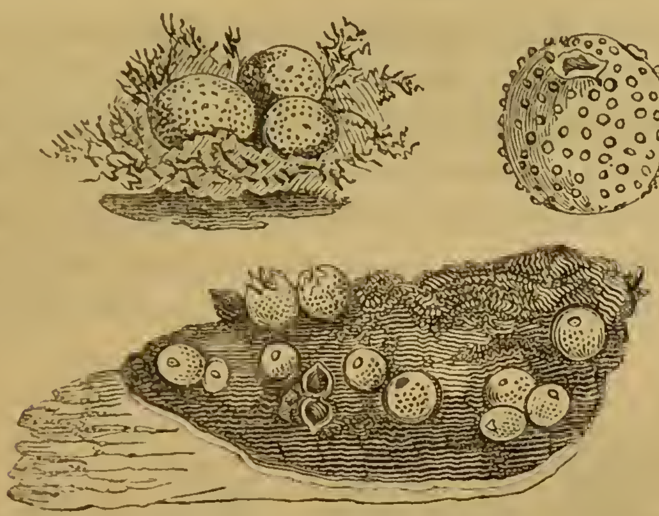
(573.) In the *Physaridæ*, "the peridium is at first pulpy, then paper-like, or crustaceous, persistent, and bursting at maturity, The sporidia are crowded, and irregularly interwoven with but few flocci."

Lycogala (the wolf-milk), is perhaps one of the best known British examples of the subtype *Physaridæ*. In an early state the pulpy peridium of this plant contains a mass of whitish matter resembling clotted cream. Like its allies, it is found on rotten wood and decaying leaves. The pulpy contents of these plants undergo some curious changes, both in consistence and colour, during maturation. The white or whitish clots of the *Lycogalæ* are converted into masses of fine brown powder of different shades, and absolutely impalpable; mixed with gum-water, they afford excellent pigments.

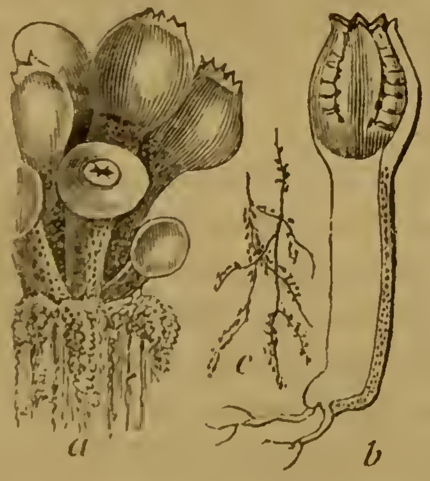
(574.) In the *Bovistidæ* (Lycoperdinei of Fries), "the peridium, at first of a soft fleshy consistence, subsequently becomes firm like leather. It is persistent and dehiscent, and always double; the outer stratum, however, cracking, and forming a scaly, warty, or powdery layer over the inner coat. The flocci are abundant, and woven together into a soft sporangium. The sporidia are attached to the flocci, not crowded together, but dispersed in equal groups."

(575.) *Lycoperdon* (the wolf puff-ball), and *Bovista* (the bull puff-ball), with *Geastrum* (the ground-star), are among the most important and curious illustrations that can be given of this sub-type. The former genus is common on most of our heaths and pasture-lands. When the peridia burst, the sporules, which are

Lycoperdon pisiforme.



emitted in vast abundance, have something the appearance of smoke rising from the fungus; hence their common names of puff-balls, blindman's buff, or devil's snuff-boxes. The powder contained is curious, like that of the Lycogalæ, for the variations in colour it undergoes; at first the mass is white, moist, and spongy, subsequently it becomes dried and of a dirty green hue, and ultimately quite pulverulent and of a dark brown colour. This powder is further remarkable for its property of strongly repelling moisture. If a basin, says Keith, be filled with water and a little of



Lycoperdon pyriforme.

(*a*) Group of plants.

(*b*) Section of peridium, shewing the dehiscent apex.

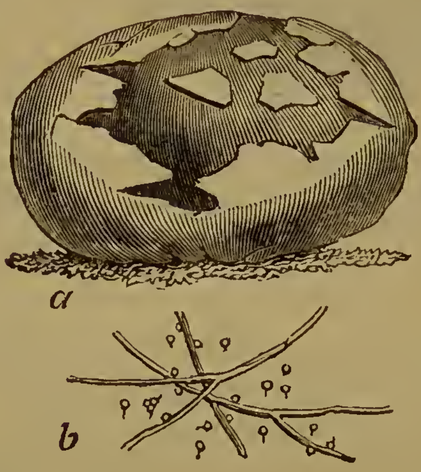
(*c*) Filaments, with sporidia attached.

Last figure much magnified, the others diminished.

the powder be strewed upon the surface, so as to cover it thinly, the hand may be plunged into it, and thrust down to the bottom, without being wetted with a single drop of water.

Lycoperdon Bovista [§ 578, fig. D, E, F, G,] is one of the largest species. *Lycoperdon pyriforme* is not a terrestrial plant, but grows in clusters on the trunks of old trees. These fungi have not been applied to any useful purposes.

(576.) Of the genus *Bovista*, the bull puff-ball, or, as it is called in some of our provinces, the frog-cheese, we have but two British species, one of which, the *gigantea*, is peculiarly interesting, both from the immense size that it occasionally attains, and also for the almost incredible rapidity with which it grows. In the museum of King's College, London, there are preserved several fine specimens, the largest of which measured, when found, between four



(*a*) *Bovista gigantea.*

(*b*) *Sporidia* and *filaments*, magnified; the outer layer of the peridium cracking into scales.

and five feet in circumference. They sometimes, however, reach a much greater size. Bulliard mentions having seen them above two feet in diameter, and affirms, on what he considers good authority, that they occasionally reach the enormous bulk of nearly nine feet in circumference.

It is probably the smoke that arises from these fungi when burned, or some of their allies, the Lycoperdons, which forms the secret method advantageously employed by some persons who keep bees, in order to stupify the insects without killing them, while their hives are being robbed of all their honey. Gerarde says, it is the common species of Lycoperdon, L. bovista, which the country people burn, to kill or smoulder their bees. If the bees are prevented escaping, they are of course destroyed; but,

otherwise, they quit their cells until the smouldering has ceased, leaving ample time to take away the honey.

In many places, and especially in our northern counties, these fungi are used instead of tinder; and "in some parts, where the neighbours dwell far asunder, to carry and reserve fire from place to place, whereof one species took the name of *Lucernarum fungus*." (Gerarde.)

(577.) An Italian species, *B. furfuracea*, which is said to be abundant on the heaths near Florence, is collected and sold in the markets, with some others of its allies, being an esteemed article of food.

Geastrum (the ground-star), shews the double peridium better than any other genus; all the outer stratum being separated from the inner in regular lobes. The species are extraordinary

Geastrum multifidum.

(*a*) Entire plant.

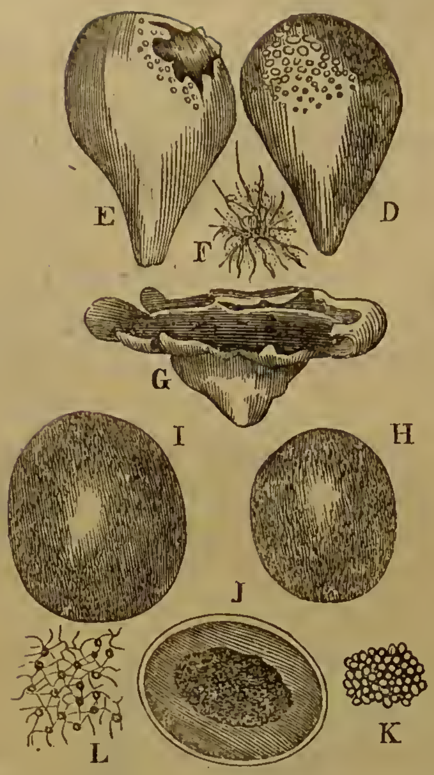
(*b*) Plant, with section of the internal peridium.

(*c*) Young plant in the act of bursting.

(*d*) Filament springing from peridium, and bearing sporidia.

plants as to their external structure; the resilience is so great in G. fornicatum, as to raise the body of the fungus upon arches formed by the elastic peridium; and the other Geastra, as coliforme and multifidum, well merit their names, 'stars of the earth.' These fungi shew a very near approach to the structure of the next section, especially in the peridia.

(578.) *Sclerodermidæ*, *Scleroderma* and its allies, *Diderma*, *Elaphomyces*, &c. form the last subtype of the Bovistaceæ. In these plants the peridium is corky, or even coriaceous, approaching the consistence of horn, persistent, and double. The outer stratum is, however, for the most part scarcely demonstrable, from its close connexion with the inner. The flocci are variously conjoined, forming and supporting spurious sporangiola. The sporidia are therefore often collected together.



D. *Lycoperdon bovista*, entire plant, with the outer layer of the peridium degenerated into scales.

E. Ditto, shewing the lacerated dehiscence.

F. Floccose filaments bearing sporidia.

G. Old fungus, after having discharged its spores.

H, I. Elaphomyces officinalis, with warty peridia.

J. Section, to shew the corky structure of the peridium.

K. Small portion of peridium magnified, to shew the warty coating.

L. Filaments with sporidia.

By the Germans one species of Elaphomyces, viz. the officinalis, is considered a medicinal plant.

(579.) Collectively, the subtypes *Sclerodermidæ*, *Bovistidæ*, *Physaridæ*, and *Trichiadæ*, form the type Bovistaceæ, (*Trichospermi* of Fries,) the last that occurs in the section Bovistinæ.

The following are the associating and distinctive characters of the type. "Peridium distinct, continuous, and of a determinate figure; including naked pulverulent sporidia, crowded amongst the flocci."

(580.) The types *Bovistaceæ*, *Spumariaceæ*, and *Sclerotiaceæ*, form, together, the section Bovistinæ, a section which includes four fifths of the plants ordinarily known as *Gasteromycetes*. This section is, perhaps, most readily distinguished by negative characters, viz. from the following section, by the peridia being not discrete in any of the types; for, even in Geastrum, it is only the outer layer that is free; the inner, if not both, being either concrete with the flocci, interwoven with the sporidia, or confused with the general mass of structure: and from the preceding section they are equally well known by their destitution of a nucleus.

TUBERINÆ.

(581.) Whether Tuber (the truffle), with its allies, *Phallus*, *Nidularia*, and *Carpobolus*, should be distinguished as a section, or only esteemed a type of the *Bovistinæ*, is a point not yet universally decided; but it is not one of very great importance. They are fungi, which, being just on the confines of the present order, foreshadow, by their structure, some of the organs which are characteristic of the next. Indeed, until lately, several of them were associated with the following order, the *Boletales*. Since, however, their structure has been better understood, it is evident that their closest affinity is with the *Bovistinæ* and *Sphærinæ;* from which, however, they so far differ as to give great sanction to the arrangement of those who elevate them to the rank of a co-ordinate section.

(582.) Nidulariaceæ. *Carpobolus* (the projector), and *Nidularia* (the nestlet), are the normal genera of two small subtypes included in the common type Nidulariaceæ. Conjoined, they are characterized by their "discrete peridia, and consequently, free sporangia;" their chief points of difference being the respective elastic and non-elastic dehiscence of their peridia: so that, in the one group, the sporangia are projected to a distance, and in the other, remain quietly within their nestlike pouches.

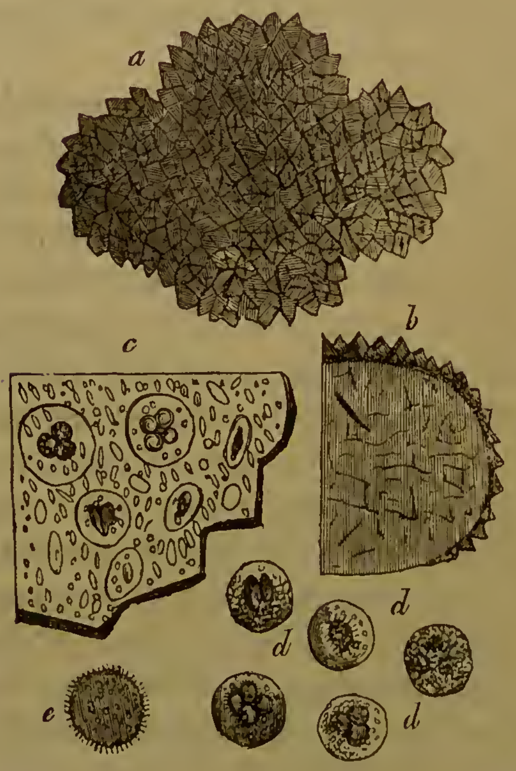
(583.) *Carpobolidæ*. *Carpobolus*, and its allies, *Sphærobolus*, *Pilobolus*, and *Atractobolus*, form that subtype which is distinguished by "the solitary discrete sporangium being elastically protruded from the peridium in which it was at first included."

These are very curious plants, as will be seen from the following abridged history of the Sphærobolus stellatus, which is given more at length by Greville. This remarkable plant, in its early state, is covered by a fine woolly or cottony web, that is very evanescent. When the young Sphæroboli have pushed through this web, they have the appearance of smooth round balls, rather larger than mustard-seeds. The outer peridium is of a firm fleshy texture, the inner membranaceous. This inner peridium, which is very tenacious, contains a single sporangium, or ball of sporidia. At the time of the dehiscence of the outer peridium, the inner one, then concave, with its mouth uppermost, with an inconceivable rapidity and force turns itself inside out, and projects the ball of sporidia,

like a bomb from a mortar, to a distance of several inches. So great is the force with which the ball is projected, that the cracking noise it occasions is distinctly audible; and frequently, besides the sporangium, the inner peridium, somewhat resembling a balloon in miniature, is shot forth likewise, and takes a short aërial voyage. "This is unquestionably," concludes Dr. Greville, "the most wonderfully constructed plant which it has fallen to my lot to describe in the Scottish Cryptogamic Flora. That so great a degree of force should exist in a body not larger than a pin's head, and that force exerted in defiance of considerable resistance, seems to surpass the power of anything to account for it satisfactorily."

(584.) *Nidularidæ. Nidularia* (the nest-mould), with its allies, *Myriococcum*, *Polyangium*, &c., are associated into a subtype, distinguished from the preceding by having their sporangia, although free, included within their peridia. They are elegant fungi; and not only do their open peridia resemble nests, but their sporangia may be likened to little eggs. In some, the sporangia are not invested with filaments; in others, the egg-like bodies appear as if packed in cotton.

(585.) Tuberaceæ. The truffle (Tuber cibarium), so long and



Tuber cibarium.

(*a*) An entire fungus, shewing the irregular surface of the peridium.

(*b*) Section of the same, shewing internal structure.

(*c*) Ditto magnified, to shew the sporangiola, with the sporidia within them.

(*d* and *e*) Sporangiola separate.

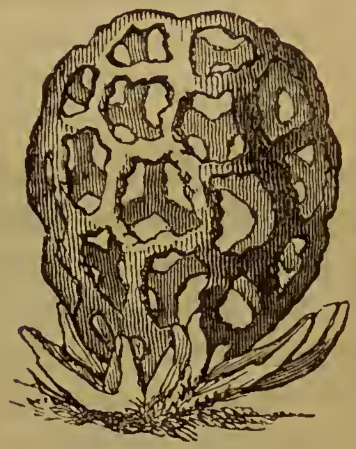
so much prized by epicures, that it has received the specific synonyme of *gulosorum*, will form the most familiar example of the type Tuberaceæ. The odour of these subterranean fungi is peculiar, and must be penetrating; for animals, such as pigs and dogs, are trained to hunt for them, and they are said unerringly to scent and indicate their prey, though covered by a stratum of earth ten or twelve inches thick. Even the human species appears to have sometimes an equally acute sense of smell developed; for, an instance has been recorded, in which a man hunted for, and discovered truffles, with a degree of success quite equal to that of the trained pigs and dogs.

(586.) *Tuber*, *Rhizopogon*, *Polygaster*, and their immediate allies, are associated together, and distinguished from the contingent types, by having their "sporidia enclosed in membranous sacs (*sporangiola;*) they are numerous, and contained within a peridium, which often assumes internally a veined or cancellated structure," foreshadowing, as it were, the hymenium of the following order; as the sporangiola may be considered forerunners of their asci.

(587.) Both the truffle (Tuber), and the root-beard (Rhizopogon), have been commended as articles of diet. The latter emerge from the soil, and somewhat resemble middling-sized potatoes lying on the surface. By most persons they would be considered scarcely esculent, were it not believed that they possess aphrodisiacal powers. It is probably a like unmerited fame which has contributed to keep the truffle so long a favourite, for its flavour is very trifling. Truffles vary much in colour, being found of almost every shade, from a deep brown to white. The dark sorts are the most esteemed. They grow, but not abundantly, in our midland counties; they are much more common on the continent, especially in the south of France and Italy, whence they are imported in considerable quantities into this country: they are indigenous also to the East Indies and to Japan. A light dry soil seems most favourable to their growth, but they are apparently most capricious plants, (*i. e.* we do not know the laws which regulate their transits;) for, notwithstanding their subterranean habitats, which might have been expected to have restrained their migrations, they wander from place to place, quite as much as any other individuals of this essentially nomadic class. Probably their spores are conveyed, like those of the Rhizoctoniæ, by the water that drains through

the soil; and perhaps they, and their hypogean associates, are destined to perform similar duties below, that epigean fungi do above, the surface of the earth.

(588.) PHALLACEÆ. *Clathrus*, *Laternea*, [§ 57, fig. C,] *Phallus*, [§ 57, figs. A. and B, § 590,] and their allies, afford examples of the gradual change of development which takes place towards the conclusion of this order, preparatory to the evolution of a new



Clathrus cancellatus,

Shewing the laciniate dehiscence of the peridium, and the cancellated structure of the receptacle.

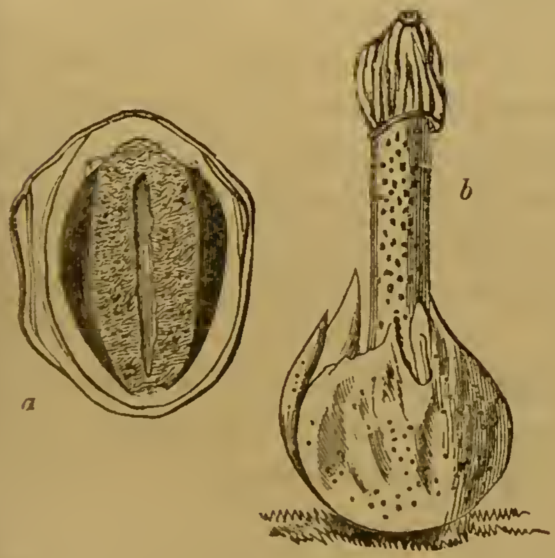
series of organs in the next; the peridium assuming the form of a volva, the column-like receptacle of a stipes, which is surmounted with a rudimentary pileus; and in some species, as in the Phallus indusiatus, [§ 57, A,] there is even a veil produced.

(589.) The Phalli, or stink-horns, are solitary fungi, growing frequently on rotten wood, at others, in the ordinary soil: they are peculiarly affected by meteoric changes, and towards the end of summer, and in the autumn, especially after thunder-storms, they are by no means very uncommon. But, from the suddenness of their growth, and the rapidity of their decay, they often pass through their ephemeral existence wholly without notice. Perhaps the strong and offensive odour of the most common species, far more disagreeable than putrefying flesh, may cause many rather to turn away from the spots where they grow, than to seek, by such a guide, for one of the greatest curiosities of the vegetable world. In its early stage, this strange fungus very much resembles an egg, both in shape and colour, [§ 590.] In this larva or nymph-like state, it remains for two or three days, preparing for its subsequent metamorphosis. When fitted for its evolution, it suddenly bursts through its peridium, and attains, within a few hours, (varying from one to five,) its full growth, which is usually six or eight inches in

height, by two or three in circumference. Bulliard affirms that the rupture is so violent, as sometimes to be accompanied with a report as loud as that of a pistol; and that, if it be placed in a glass or earthenware vessel, just large enough to receive it, with a little water at the bottom, the vessel is broken when the volva bursts.

To explain this sudden and astonishing growth, the structure of the plants must be minutely examined; and, as Dr. Greville says, "in regarding this wonderful elongation, it is worthy of remark, that while the stipiform columella is confined within the volva-like peridium, the cellules, which compose the greater part of its substance, are so much vertically compressed as to make their parietes assume the form of short horizontal lines crowded together; but, on the other hand, when it is mature, the cellules are roundish." It is therefore to the vertical distention of numerous compressed series that this phenomenon must be, in great part, attributed.

(590.) *Phallus fœtidus*, the stinking Phallus, affords the most familiar British illustration. Previous to the rupture of the peri-



Phallus fœtidus.

(*a*) Young state included in peridium.

(*b*) Stipes, &c. after rupture, shewing the volviform peridium, the stipiform columella, and the pilei-form summit.

dium, this plant, which is subsequently so offensive, is perfectly scentless; but, immediately on its bursting, and on the escape of the lengthened axis, or stipes, the summit or pileus of which is covered with a dark-green viscid slime, the stench becomes intolerable. The slime, at first, is of considerable thickness, but, in the course of a few hours, it liquifies, and drops off, and the cells of the upper surface of the cap are then exposed.

This slimy substance, which exhales the odour peculiar to the plant, is likewise the receptacle of the sporidia. Flies are said to be so fond of this offensive matter, that it is always greedily devoured by them. They do not, however, resort to it for the purpose of depositing their eggs, as they often do, by an error of instinct, in other fungi, mistaking them for putrefying flesh; but for the purpose of regaling themselves on it as food. The fœtor arising from this plant, even when diluted by passing through and mixing with the air, is so great, that, as Greville says, "few persons will believe it to lose its offensive character, when held immediately under the nose." I can, however, add my testimony to that of Greville and Withering; and aver, that such as have the courage to smell it closely will find it less disagreeable than at a distance; for it then seems to have a slight pungency, like that of volatile salts. Hence, notwithstanding its disgusting odour has almost forbid my gathering it, I have carried the specimen home, by keeping it as near to my nose as possible, with little or no annoyance.

(591.) Their disagreeable smell has led some people to assert that their taste is nauseous likewise, and even to stigmatize them as being "*highly poisonous.*" Persons, however, who are bold enough, may eat them without fear: Johnson says, the white part of the stalk is rather agreeable than otherwise. In Holland they are made into poultices, as a domestic remedy for rheumatism. The warmth of the application, and the slight stimulus of the ammonia the phalli contain, may render such poultices in some degree serviceable.

(592.) The Phallaceæ are characteristically distinguished by their discrete receptacles being protruded through the ruptured peridia, and by a mucous layer forming the nidus in which the sporidia are lodged.

(593.) The Phallaceæ, associated with the Tuberaceæ and Nidulariaceæ, form the common section *Tuberinæ,* (called by Fries the Angiogastres.) The collective and distinctive characters of the section will be found in "the sporidia being deposited in proper receptacles, distinct from the peridium."

(594.) The three sections last described, viz. the *Tuberinæ,* the *Bovistinæ,* and the *Sphærinæ,* constitute collectively the order

TUBERALES. The characters of this order have been already given, in detailing those of its several sections; it now only remains to repeat them in a collective form, and to state that the Tuberales are fungi entirely closed; thus forming a pouch, (peridium or perithecium,) within which the sporidia and other organs are contained."

(595.) The following table affords a conspectus of the various types and sections included in the order, with references to their definitions.

Order.	Sections.	Types.
TUBERALES (594)	Tuberinæ (593)	*Phallaceæ* (592)
		Tuberaceæ (586)
		Nidulariaceæ (582)
	Bovistinæ (580)	*Bovistaceæ* (579)
		Spumariaceæ (565)
		Sclerotiaceæ (564)
	Sphærinæ (532)	*Sphæriaceæ* (527, 532)
		Phacidiaceæ (525)
		Xylomaceæ (517)

BOLETALES.

MYCETALES, OR HYMENOMYCETES.

(596.) The most common eatable and poisonous fungi, known familiarly as mushrooms and toadstools, are associated, to form an order, which, from one of the normal genera (*Boletus*), is called the BOLETALES. Βωλίτης, *Boletus*, was formerly used to designate many, if not most, of the then known fungi belonging to this order, some of which are now called Agarics, and others have other modern appellations. Hence from it the order has been named, and its derivation from Βωλὸς, a field or pasture, still further strengthens its claim to give a collective title to the meadow mushrooms and their allies. *Hymenomycetes* is another name which has been given to this group: it refers to a peculiar structure common to the whole, which is denominated the *Hymenium*, [§ 600, fig. A. c.] It was probably to some of these plants that the old Greek word (*mykes*) μύκης, and the modern French *champignon*, or *field-pinion*, were originally applied, [§ 444]: hence *Mycetes*, or *Mycetales*, would be very fit collective terms, did not one, derived as above from a normal genus, afford a preferable denomination.

(597.) The genera contained in this present order are esteemed the only true *Fungi* by many writers; those which form the preceding orders being excluded, and called by other names. Such a scheme does not, however, appear to be advantageous either as an artificial index, or as a natural arrangement. Hence, the word Fungus is here used in its most familiar and extended signification, as the name of a large group or class, of which the *Boletales* or *Mushrooms*, the *Tuberales* or *Puff-balls*, and the *Mucedinales* or *Mildews*, are esteemed the constituent orders.

(598.) Several of the types in the preceding order not only prefigure, but so nearly approach the characteristic structures of the present, that the faintly drawn line of demarcation has sometimes included them in this division, and sometimes in that; so likewise it is found, in this present order, that the various types of its boundary section have the distinctive and peculiar forms so imperfectly developed, that their location seems questionable, and their present arrangement is founded rather on negative than on positive characters. The *Sclerotiaceæ* and *Phallaceæ* are examples of the first, the *Tremellaceæ* of the second, proposition.

(599.) These inosculations, it will be noted, are not peculiar to this or to any other order, but are common to all. The organs which are developed in the normal groups of the BOLETALES, are quite as peculiar and distinctive as those which characterize the preceding orders. But here, as there, although most distinct in the normal genera, the distinctions wane, and the strong contrasts disappear in the conterminal types and genera.

(600.) The external organs or members developed in these fungi are, the *volva*, or *wrapper* [fig. A, B, *a*, *a*], which supersedes the peridium and perithecium of the Tuberales. The *velum*, or *veil* [fig. A, B. *b*, *b*], which, when ruptured, becomes the *annulus*, *collar*, or *ring*, [fig. A, *b*; D, *a*; E, *c*; G, *c*]. In the early stages of growth, the veil covers the *hymenium*, or *fruit-fold* [A, *c*; B, *c*]; between the plates or within the pores of which are situated small lengthened cells or tubes, called *asci* [§ 614, fig. *b*]. The *asci* are present in most of the Boletales, and they contain, as in the sphærinæ, the *Sporidia* or *Spore cases*. The *hymenium*, or *fruit-fold*, is attached to, or forms part of, the *pileus*, or *cap* [A, *e*; B, *d*; D, *b*, &c.]; and the pileus, or cap, is often supported by a

stipes, or *stalk* [A, *f*; E, *a*, &c.], and the fleshy part is sometimes called its *receptacle*.

A. Agaricus imperialis (or Amanita muscaria), full grown. B. Ditto in a young state.

A, *a*. Volva, or wrapper, burst. (*b*) The veil become the ring or collar, annulus. (*c*) The hymenium. (*e*) The pileus, covered with warts formed by fragments of the ruptured volva. (*f*) The stipes.

B, *a*. The volva bursting. (*b*) The veil still attached to the edge of the pileus, and covering the hymenium. (*c*) The hymenium. (*d*) Section of the pileus, shewing the solid receptacle distinct from the hymenium. (*e*) Section of the stipes.

C. Spores.

D. Section of E, to shew the annulus (*a*); the solid receptacle (*b*); and the lamellated or gill-like structure of the hymenium (*c*.)

E. Agaricus campestris, full-grown. F. Ditto, in a young state.

E, *a*. Stipes. (*b*) Pileus. (*c*) Annulus. (*d*) Lamellated hymenium.

G. Another view of the same species, the references as in E.

H. A dried specimen of Agaricus pratensis, the common champignon.

I. A nodule of iron pyrites, having a fungöid shape.

(601.) In some of the more elaborately constructed fungi all these organs are present, but in others they are variously blended, or abortive; and upon the differences observable in their development the order has been distributed into sections, types, and genera.

(602.) When the centripetal and centrifugal forces are balanced, both the stipes and the pileus are equally evolved; but when either

predominates, the evolution of the axis and the radius are favored in turn. Thus, sometimes, the axis is inordinately developed, and the pileus assumes the form of the stipes, as in the *Clavariaceæ*. At others the pileus becomes unilateral; and again, when the radial force is further predominant, the stipes becomes altogether lost, as in the *Auriculariaceæ*, *Exidiaceæ*, and in many of the *Boleti*, and *Agarici*.

TREMELLINÆ.

(603.) Dillenius gave the name *Tremella* to an incongruous group of plants, which agreed in few other particulars than their gelatinous and tender substance, and the tremulous motions they exhibited on the slightest external agitation. Some of these misunderstood vegetables are fungi, some Algæ, and some considered such, are not plants at all. ence, as they were respectively examined by subsequent naturalists, the Tremellæ were arranged by one author, as by Linnæus, with the Algæ; and by another, as by Persoon, with the Fungi; while a third party, as Smith, perceiving their doubtful affinities, designated them Algæ ambiguæ. Those which are truly flags have been already described amongst the Nostochinæ [§ 149, *et seq*.]; those that are determined to be fungi will be included in the section Tremellinæ.

(604.) The former undetermined nature of these plants led many persons to doubt whether they were vegetables at all, which doubts were strengthened by various other matters being confounded with, and mistaken for Tremellas. Thus, Withering has shewn several specimens of supposed Tremella to be only the remains of frozen frogs; and others have been deceived into collecting, for these fungi, the jelly-like lumps of skin and bones which are disgorged by herons, and other birds. The above will shew the confusion in which these plants were formerly involved, and from which they have been rescued by the labours of modern mycologists. They will also serve as illustrations of the precious materials from which Paracelsus and other alchymists endeavoured to extract their boasted panacea, or elixir of life. Geoffrey states, that from these substances it was also hoped the universal solvent might be procured. The unknown being mistaken for the wonderful, the obscurity of these plants was considered decided evidence of some important mystery being concealed by them.

(605.) Tremellaceæ. *Hymenula* and *Tremella*, with their

respective allies, form two subtypes, the *Hymenulidæ* and *Tremellidæ*, which together constitute the type *Tremellaceæ*. Most of these plants are common, abounding on the trunks of trees, fallen branches, and decaying wood. By our foresters they are variously named, according to their forms and consistences, "Witch-guts," "Witch-meat," and "Witches'-butter."

(606.) *Hymenulidæ*. *Hymenula*, the normal genus of this subtype, has received its name from the circumstance of the complex structure prevalent in the order generally, being in it reduced, as it were, to the Hymenium alone, within which the sporidia, destitute of asci, are contained. The Hymenulæ, thus reduced to the simplest state possible in the Boletales, have a good deal the aspect of some sclerotia, especially Sclerotium durum; and hence they very properly bound the order. The distinctive characters of the subtype will be found "in the leathery or waxy consistence of the plants it includes, and in the sporidia being often obsolete."

(607.) *Tremellidæ*. *Tremella*, the quaking mould (from *tremo*, to tremble), and *Dacrymyces*, the tear-mould (from δακρυ, a tear, and μυκης, a fungus,) one of the wood-destroying fungi which commit such havoc among timber whenever allowed to gain a settlement, may serve as examples of the subtype *Tremellidæ*,

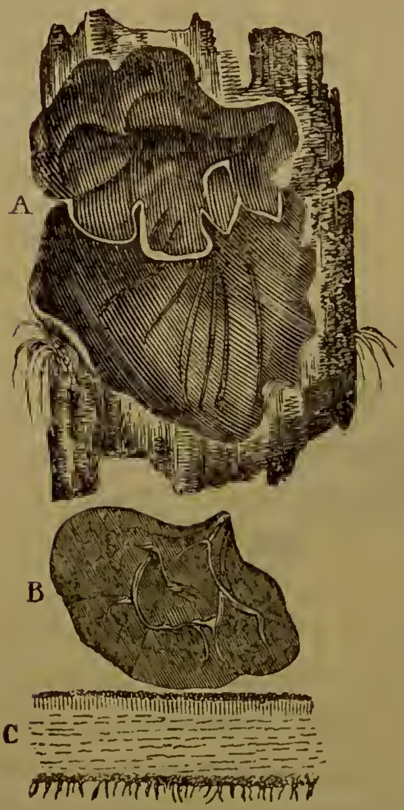
Tremella mesenterica.

which is most readily distinguished from the Hymenulidæ by the more gelatinous consistence of the receptacle; but the hymenium being naked, and mostly fruitful on both sides, forms the more important character. None of the Tremellæ are known to be

hurtful: they are very mucilaginous; and are said to be refrigerant; but, being devoid both of smell and taste, are not employed either as food or as medicine. Tremella mesenterica is reported to dye yellow, and T. fimbriata to afford another dye-stuff. These plants vary extremely, according to the soil and season in which they grow. On moist timber and in wet weather they are deliquescent, and resemble the Palmellæ and Nostocs; in droughts, they shrivel up, and become as scaly as Lichens. In general they are short-lived plants, disappearing in the course of a few weeks; but some species seem to be perennial. They are most common towards the end of autumn, and in the early part of spring. Some flourish during the winter.

(608.) The *Tremellidæ* and *Hymenulidæ*, sometimes considered as perfectly distinct groups, are here associated to form the type TREMELLACEÆ, of which the following are the diagnostic signs. "Plants gelatinous, waxy or coriaceous; *Hymenium* scarcely distinguishable from the other parts; so that it is sometimes equally fertile on every side, and sometimes the sporidia are obscure, if not abortive."

(609.) EXIDIACEÆ. The *Judas'-ear, Exidia Auricula Judæ*, is



Exidia auricula Judæ.

A. Two plants growing together.

B. Another reversed.

C. A section much magnified, to shew the hymenium.

a well-known example of the type EXIDIACEÆ, of which it is the normal genus, and to which it gives its name. The Exidiæ and

their allies, Lemalis and Hirneola, differ from the preceding and succeeding types, by having the receptacle, which is irregular and submarginate, fertile only on one side, and by the fructifying surface being superior.

(610.) The *Auricula Judæ*, which received its name from its resemblance to the human ear, was once held in much repute for its medicinal properties. It is an astringent; and, in the form of infusion or decoction, is said to be useful as a lotion in ophthalmia, and as a gargle in sore throats, accompanied with relaxation. A poultice made by steeping the fungi in milk or vinegar, has been also recommended as an external application, in similar cases.

(611.) CYPHELLACEÆ. *Cyphella* (the cave-stool), *Helotium* (the head-stool), and *Guepinia* (a genus so named in honour of M. Guepin), form, together, a small type denominated the CYPHELLACEÆ, which is distinguished from both the preceding, by having a dry membranaceous receptacle, with the hymenium inferior, and, consequently, being fertile only on the lower surface

(612.) The three types *Cyphellaceæ*, *Exidiaceæ*, and *Tremellaceæ*, which differ among themselves by having superior, inferior, and amphigenous* or obscure hymenia, are associated by the following common characters, and form, collectively, the section TREMELLINÆ. These are membranaceous or gelatinous fungi, of a floccose structure. Shape irregular, hymenium confounded with the receptacle. Asci none.

(613.) The progressive evolution of the organs peculiar to the Boletales, and which are characteristic of the order, forms a curious subject for contemplation, even in the few stages through which it has in this section passed. At first, in the *Hymenulidæ*, the receptacle and hymenium are so blended together, that the whole plant may be esteemed to consist of the latter alone; for even the sporidia are sometimes absent; and no other organs are evolved. In the *Tremellidæ* the hymenium, notwithstanding it is confounded with the receptacle, is abundantly fertile of sporidia, fructifying in every part. In the *Exidiaceæ* and *Cyphellaceæ*, the receptacle and hymenium, though still confused and indeterminate, become somewhat more distinct, the fructification being restrained to especial parts; in the one to the lower, in the other to the upper surface; and furthermore, although in this section no asci

* Amphigenous, fruit-bearing on both sides.

are formed, the tubules in Exidia, from which the sporidia are elastically ejected, may be considered the forerunners of those organs, if they are not really their rudimental states.

HELVELLINÆ.

(614.) In the Helvellinæ, the asci, which are foreshadowed by the tubules of Exidia, and which are common in the Sphærinæ or Pyrenomycetes, but which are unknown in the Bovistinæ, Tuberinæ, and Tremellinæ, again appear, and are fully and generally developed, forming an important diagnostic sign. Their presence in the *Sphærinæ* has led some botanists to associate those fungi with the *Boletales*, under the name of Ascomycetes; while the sections *Tuberinæ* and *Bovistinæ*, with respect to their destitution of asci, and being simply sporidiferous, have been contrasted, and termed Sporomycetes. Such a distribution is, however, very faulty; for, not only are other fungi, such as the *Phallaceæ*, more closely allied to the *Boletales* than are the *Sphærinæ*, but the whole of the *Tremellinæ*, and part of the *Clavariaceæ*, which are included among the ascomycetes, are entirely destitute of asci;

Helvella leucophœa.

(*a*) An entire plant.

(*b*) Portion of the superior hymenium with the asci, containing the sporidia.

(*c*) A section of the stipes.
Grev. 143.

and hence, if such a scheme were truly followed, would be severed from their natural allies, and associated with the Mucedinales, and other sporomycetes. These speculative systems are worthy no-

tice, as affording different views of important objects, which can never be contemplated from too many points; but if such views alone were taken, they would give very imperfect and partial glimpses of any science.

(615.) The HELVELLINÆ have been separated, by Fries, into two groups of equal rank; but, notwithstanding a strong desire to hold as closely as possible to his arrangement, the distinctive characters, as given in his '*Systema Orbis Vegetabilis*,' a most admirable and very learned work, do not seem to justify the division, and therefore it is not here adopted.

(616.) The *Helvellinæ* are distinguished from the preceding section, the Tremellinæ, by being *ascigerous;* and from the succeeding section, the Agaricinæ, by not having an inferior hymenium. The latter part of the definition used until lately to be expressed in the positive form, the hymenium being described in the Helvellinæ as *superior;* but Fries has endeavoured to distinguish a modification of the superior hymenium, which occurs in Clavaria [§ 620], and its allies, from that form which is common in Helvella, Peziza, &c. The latter alone he allows to be superior, the former he denominates *amphigenous;* a term which indicates a duplex fructification. But although, in some of the Clavariaceæ, the whole of the club-shaped receptacle is covered by the ascigerous hymenium, and the pileus and stipes are undistinguishable; in others, there is a head separate from the stem, and the hymenium is confined to the upper end; a position equivalent to that of the hymenium in Helvella, and differing no more from that normal genus than does its position in Peziza. In *Peziza* the centre of the receptacle is depressed, and the hymenium is contained, as it were, in a cup, while in *Clavaria* the centre is elevated, and the hymenium becomes spread over the superior or outer surface of a club. In the Tremellaceæ alone does the hymenium appear to be truly amphigenous.

Helvella leucophœa and H. mitra, are both esculent; indeed none of the Helvellinæ are noxious.

(617.) CLAVARIACEÆ. The branching or club-shaped forms of the Clavariaceæ, combined with their often polished and coralline appearance, led the older naturalists to consider them not fungi, but to associate them with the corals which were then esteemed vegetables, and denominated *Lithophytes*. Even so late as the time of Tournefort this error prevailed; and it is to Holmskiold and Persoon that we chiefly owe our present knowledge of the

true nature of these plants. The type to which Clavaria gives the collective name includes three subtypes, the *Pistillaridæ*, *Clavaridæ*, and *Mitrulidæ*, which are associated by the following characters, which are common to the whole, "receptacle elongated, with a tendency to a cylindrical form, sometimes simple, sometimes branched, not margined. Hymenium superior, (in the state called by Fries amphigenous,) asci mostly present, fixed."

(618.) *Pistillaridæ.* Pistillaria and its allies, which are the least removed from the Tremellinæ, partake more of their characters than do any of the other Clavariaceous fungi; for, although sometimes horny, they are often of a soft waxy, or jelly-like consistence. The asci are likewise very obscure, and frequently, if not always, obsolete. In the normal genus the naked sporidia emerge at the end only, although the whole surface is covered with the hymenium. In Typhula, which has been so named from its resemblance to the reed-mace, the hymenium is confined to the extremity of the club, and the asci, though not abortive, are very obscure; and hence it has been sometimes described as having none.

(619.) It has probably been owing to different mycologists examining specimens of these plants in more or less perfect states, that the discrepancies have occurred which so much vary the genera associated in each subtype; some putting *Calocera*, the fair-horn-mould (from καλος fair, and κερας a horn), along with *Pistillaria*, in which the asci are obliterated, and others, along with *Clavaria*, in which they are most distinct.

(620.) *Clavaridæ* In CLAVARIA, and its allies, *Gomphora*,

(*a*) Plant of Clavaria cristata, lessened.

(*b*) Portion of stem transversely divided.

(*c*) ——— of hymenium, shewing thecæ and sporidia magnified.
Grev. 190.

Hericium, &c. "the asci, which are distinct, are short, and the receptacle and hymenium are confluent." The hymenium, as in

Clavaria, often covers the entire surface. Hericium and Gomphora are separated from Clavaria by Fries, and formed into a distinct group.

(621.) All the *Clavariæ* are esculent, and some are much esteemed as food. *Clavaria rugosa* is commended by Sowerby, for its "agreeable taste, like that of the common mushroom; *Clavaria flava* is said to be delicious; and *C. pyxidata* tolerably good. *C. cinerea* is, however, the species most frequently eaten on the continent, yet, probably only from its being more abundant than *pyxidata*, *rugosa*, *flava*, and *corallöides*. In Italy these plants are called '*Ditola rosea*,' *bianca*, &c., referring to their colour; and in France, *barbe de bouc*, *espignelles*, and *diables*. According to the accounts given by Persoon of the continental mode of cooking these fungi, it would be strange indeed if they, or any other innoxious matters, were not edible. He says they are "stewed for an hour with butter, pepper, and salt, and then put into a gravy sauce, or a fricassee of fowls."

> "The pungent mustard and the hot cayenne,
> Will palatable make the tough old ewe."

Loureiro, when travelling in China, found an eatable species of Clavaria growing upon elephant's dung.

(622.) *Mitrulidæ*. *Mitrula* (the mitre-mould), *Spathula* (the spathulet), and *Geoglossum* (the earth-tongue), afford three admirable examples of change of shape, the last-named being simple, and like a tongue or club, the second flattened, and the other severed into two branches, like a mitre, thus approaching the ramified structure of some of the *Clavariæ*, [§ 620.] The above genera are associated, and the subtype distinguished by having the hymenium discrete, and the asci long. The hymenium likewise is only terminal, and the head is separate from the stem.

(623.) Pezizaceæ. *Pezita* and *Pezica* (from πεζὶτης and πεζικὸς, a traveller on foot), are old names given by Pliny to a group of fungi not elevated on stalks; such as with us are often called *footless stools*. The modern word, *Peziza*, is a corruption of the latter term, and is applied to designate a very large genus, which, having been distributed into several subgenera, will probably hereafter be considered a subtype. At present, however, the genus *Peziza* had better remain entire; for, although several schemes have been proposed for its subdivision, their diagnostic

signs do not, on the whole, appear sufficiently important to demand its disintegration.

(624.) The most important genera associated with Peziza in the type Pezizaceæ are *Stictis* (the sunk-mould), and *Ditiola* (the down-rot.) These two genera give names to two of the subordinate groups of the *Pezizaceæ*, which it has been proposed to distinguish from the more immediate allies of Peziza.

(625.) Fries states that in the first group (the *Stictidæ*), the receptacle is obliterated, and the hymenium immersed.

(626.) That in the second (the *Ditiolidæ*), the receptacle is sublenticular, and never closed.

(627.) That in the third (the *Pezizidæ*), the receptacle is cupulate and closed during early growth.

(628.) In all the hymenium is margined; and, this combined with the character derived from the shape of the receptacle, which, although various, is never pileiform (cap-like), will constitute the diagnostic signs between the Pezizaceæ and the following type.

(629.) The *Ditiolæ* are gregarious fungi, which grow in profusion on various kinds of immature timber, especially on deal and on barked fir-trees. They are of a firm structure and inodorous, and are remarkable for flourishing upon, and aiding in, the destruction of dry timber. Their minute fibrillæ pierce between the fibres of the wood, separate and soften them, and bring on a premature decay; for, the further they insinuate themselves, the more easily can moisture gain access; and, as the successive crops of spores become developed within these chinks, larger and larger clefts are made. A species of *Ditiola*, the *radicata*, is one of those wood-destroying fungi which are commonly known as *dry-rot*.

Fungi such as these, which penetrate through bark and wood, or others, the spores of which being absorbed by the roots, are conveyed into the very heart and diffused throughout the entire substance of the vegetable body, where, when it is in a weak or sickly state, they germinate and grow—have a power of disintegrating timber, and rending the trunks of even the strongest trees, of which persons, not accustomed to watch their progress, can form but very faint conceptions. Perhaps the following two accidental expreiments may give some, though a very imperfect, idea of the force with which they act. At different times, several of the stones in the pavement in the town of Basingstoke were observed, day by day, to be rising gradually from their beds, until they were some

inches above the ordinary level; under one of these, which weighed seven pounds, a large mushroom was found, that measured a foot in circumference. It is now in the possession of J. Simonds, Esq.* The other case is recorded by Mr. Joseph Jefferson; who says, a toadstool, six or seven inches in diameter, raised a large paving stone an inch and a half out of its bed; and the mason, who had the contract for paving, was much enraged at the idea that a weak fungus should have lifted so heavy a weight. But his uneasiness was much increased, and even his alarm excited, when, about a month after the injury had been repaired, the adjoining stone was elevated in a similar manner, and two mushrooms, not quite so large, were found beneath it; for it seemed doubtful whether the whole town of Basingstoke might not want re-paving during the term of his contract. The stones were nearly of the same size, each being about twenty-two inches by twenty-one; the last raised being tried, weighed eighty-three pounds. How great then must the distensile and rupturing power of fungi be, that grow, and distend themselves within the trunks of trees, and of other weaker plants!

(630.) *Peziza*, the normal genus, is the largest and most important included in the type. It consists of 300 species, which have been distributed into the four subgenera, *Aleuria*, *Lachnea*, *Phialea*, and *Helotium*. *Peziza* (or *Lachnea*) *coccinea*, is a most splendid fungus. In beauty of form and richness of colouring, it is second to none. The interior of the cup is of the finest carmine, the outer surface white and downy. Greville says, "without much poetical exaggeration, this beautiful Peziza seems to be clothed with a fur robe lined with the richest velvet." It is truly one of

> "The beauties of the wilderness,
> That make so gay the solitary place,
> Where no eye sees them."

(631.) Peziza æruginosa is also a remarkable species. Its colour is of a deep verdigris green, which is of equal intensity throughout its whole substance; it possesses the curious property of staining the wood upon which it grows to the depth of two inches or upwards, of the same colour with itself. Greville observes, that this extraordinary property forms a most useful character of the *Peziza æruginosa*; for, so variable is it in other

* Basingstoke; July 3, 1830.—*Hampshire Advertiser.*

respects, that even its genus has been considered doubtful. Such pieces of discoloured wood are not unfrequently met with in groves and forests; some of the larger masses, however, which are stained green throughout, probably owe their discolouration to some other cause.

(632.) The *Pezizæ*, in general, are of a tough leathery consistence, and not esteemed as food. Persoon, however, says that the larger ones, dressed in the same manner as the Morels, may be eaten without fear. The Pezizæ emit their smoke-like sporules from their cupped receptacles, in the same manner as some of the Lycoperdons.

(633.) HELVELLACEÆ. Small savoury potherbs were by the ancients called Heluellæ (or Helvellæ), a word derived from *helluo*, a glutton, or the verb *helluor*, "to gormandize," because they stimulate the appetite. The same term appears to have been applied by Cicero to certain sapid fungi; whether or not to our modern eatable Helvellæ, is unknown: but, however this may be, the name has been adopted, and is peculiarly fitted for the common denomination of a type which contains some of the most delicious mushrooms that epicures desire, and to encourage the growth of which whole forests have been burned.

(634.) *Morchella*, *Verpa*, and *Leotia*, are genera associated with *Helvella* to form the type HELVELLACEÆ. They agree in having a pileiform or cap-like receptacle, which is never closed. The hymenium also in these plants is immarginate.

(635.) Helvella, as now generically defined, does not include fungi so much prized by modern epicures as the allied genus *Morchella*: some few, however, are still esteemed. *Helvella crispa*, is said to be excellent as an article of cookery. *H. lacunosa*, which is often confounded with it, although edible, is by no means so good. *H. esculenta* has a fine flavour, and is frequently substituted, and commonly eaten for the true morel; but it is far inferior to that celebrated fungus. Its qualities are nearly the same as those of the morel; and it is popularly confounded with it in Sweden, Germany, and other places. In Sweden both are called, indifferently, *Stenmurkla*, and in Germany, Gemeine Morchel, and Stockmorchel. *H. infula*, the true H. mitra of Ruppius and the older botanists, is also esculent; indeed, none of the species are poisonous, or in any respect hurtful: but, with the exception of those above named, they are in general insipid and

inodorous. The Helvellæ are permanent, somewhat fragile fungi, growing upon the earth, or upon very wet wood, and are chiefly found in the autumn.

(636.) *Verpa* is the connecting link between this type and the preceding, through the genus *Vibrissea* of the *Ditiolidæ*, to which, according to Fries, it is allied.

(637.) *Leotia* is a name given by Sir John Hill, without any known reason, to a group of fungi which, like their allies, are innoxious, and, in general, devoid both of smell and taste. Hence they are not eaten, with the exception of one species, the *L. amara*, a native of Cochin-china, which is said to be deprived of its bitterness, and rendered eatable, by long stewing. (*Loudon.*)

(638.) *Morchella*, a name formed by Dillenius, from the German *Morchel*, designates the genus in which the delicious *morels* are found. *Morchel* seems to be derived either from *mörk*, a word signifying *dark*, in the dialect of Lower Germany, or from the German *moor*, a moor or morass. There are several species of morel, none of which are poisonous, but some are barely esculent, while others are most grateful to the palate; and others, again, so vapid and watery, and so soon becoming fœtid, as to be wholly unfit for food. *Morchella esculenta*, *patula*, and *deliciosa*, especially the latter, are the species most esteemed. As condiments, they are among the most valuable of the fungi. They are seldom eaten alone, or cooked when fresh, but are dried; and may thus be preserved for months, and even years, and are employed from time to time as an ingredient in soups and sauces. Persoon, however, commends them when stewed for an hour with butter, pepper, salt, parsley, and ham, in a good gravy; when nearly done, the yolks of a few eggs should be added, and a little cream: they are served either by themselves, or on a buttered toast. Paulet gives directions for stuffing morels with savoury viands, such as pickled pilchards, craw-fish, the flesh of fowls, &c. and says, after they are broiled, they are to be served up with champaigne, lemon-juice, and bread-crumbs.

The German peasants, who found it a profitable employment to collect morels, having observed that they grew most freely and abundantly in those places where wood had been burned, absolutely set fire to the forests in many places to favor their propagation; and to such an extent did this injurious practice

proceed, that it became necessary to enact severe laws for its suppression.

(639.) The three types *Helvellaceæ*, *Pezizaceæ*, and *Clavariaceæ*, now illustrated, associate to form the section HELVELLINÆ, a section which includes the *Elvellacei* and *Clavati* of Fries, which although only subordinately distinct, are primarily severed by him for the reason already given. The superior ascigerous hymenium, occasionally assuming the amphigenous form, is the common character in which these types agree, and by which the section is distinguished from those that precede and follow.

AGARICINÆ.

(640.) As the RHA, or *Wolga*, gave its name to several species of Rhubarb, (*e.g.* the RHA-*barbarum*, RHA-*ponticum*, &c.) so from AGARUS, a river in Sarmatia, the name AGARIC (Agaricus, ἀγαρικος) was derived, and given to certain fungi that were common on its banks. It is more than probable, from the descriptions of Pliny, that the ancient Agarics of Sarmatia were identical with some of the species still included in the modern genus Agaricus, the most extensive and important in the section to which it affords a collective name.

(641.) Amongst the AGARICINÆ will be found examples of the most highly developed fungi known; plants in which the scheme of construction prevalent in the class appears in its most elaborate and perfect forms. Agaricus and Boletus are indeed the normal genera from which all the others may be considered as deviating groups; some tending towards the lower Algæ, and some towards the Lichenales, while these are unlike anything out of their class.

(642.) The *Agaricinæ* are distinguished from the two other sections, in the order *Boletales*, by having their hymenia distinct, ascigerous, and *inferior* characters peculiarly differential, and contrasting strongly with the *superior* ascigerous hymenia of the Helvellinæ and the confused sporidiferous hymenia of the Tremellinæ.

(643.) Three types are included in the section AGARICINÆ, of which *Auricularia*, *Boletus*, and *Agaricus*, are the normal genera; and hence they are called *Auriculariaceæ*, *Boletaceæ*, and *Agaricaceæ*. Fries has formed a fourth group, by associating part of the

Boletaceæ with *Radulum* of the *Auriculariaceæ*, but excepting that, by this, his quaternary scheme is completed, no reason can be offered for separating Fistulina so far from Boletus, of which genus it was once considered to be a species.

(644.) AURICULARIACEÆ. *Auricularia*, the *ear-stool*, with *Radulum*, *Thelephora*, and *Stereum*, form the type *Auriculariaceæ*, the distinctive characters of which will be found in the structure of the hymenium; for in all it is either tuberculate, papillose, or smooth.

(645.) Were the genera numerous that are included in this type, three subtypes might be formed from the above-named variations in the structure of the Hymenium. *Auricularia*, *Stereum*, and *Coniophora*, in which the hymenium is smooth, might be associated as the *Auricularidæ;* while *Thelephora*, in which it is subpapillose, and *Radulum*, in which it is tuberculate, might be esteemed the normal genera of the *Thelephoridæ* and *Radulidæ*. But, although both *Thelephora* and *Auricularia* contain several subgenera, or tribes, any further division is not at present essential, and therefore not to be commended.

(646.) BOLETACEÆ. *Hydnum* and *Fistulina*, *Polyporus* and *Boletus*, *Dædalea* and *Merulius*, which, with various other allied genera, are included in the type BOLETACEÆ, afford examples of an interesting series of structural gradations, that connect the tuberculate, papillose, and smooth Auriculariaceæ, with the plicate and lamellate fungi of the following type.

(647.) In *Hydnum*, and its allies, *Irpex* (the rake-stool), and *Fistulina* (the pipe-stool), the hymenium is subulate. In *Boletus*, and its allies, *Polyporus* and *Porotheleum*, the hymenium is porous. In *Merulius* (the wood-rot), and *Dædalea* (the maze-stool), the hymenium is sinuate.

(648.) These therefore are the collective characters of the type, which is thus distinguished from its co-ordinates, by having the hymenium either subulate, porous, or sinuate.

(649.) These gradations of structure may be considered characteristic of three subtypes, as they certainly are of three stages of development; but, although the BOLETACEÆ may thus be distributed into the minor groups *Hydnidæ*, *Boletidæ*, and *Merulidæ*, still these pass so insensibly into each other, that the distribution is the very reverse of a division. The discrete pipes of the hyme-

nium in Fistulina shew the close connexion of the *Hydnidæ* with the *Boletidæ*, by the concrete tubulous pores of *Boletus*; and the simply porous hymenium of *Polyporus* passes into the sinuous hymenium of *Dædalea*; both being still farther alike, in having the pileus and hymenium concrete and homogeneous.

(650.) *Hydnidæ*. The Hydna (*ὕδνα*, or *οἶδνα*, of the ancient Greeks), would appear to have been tuberiform fungi, and the term *hydnum* (or *ὕδνον*, from *οἰδέω*, to swell,) to have been equivalent to the tuber of the Romans, and our truffle. It is therefore probable that this name was not applied to any of the species included in the modern genus, many of which are of a loose, bristly, and flocculent form, often resembling spines, or dishevelled hair.

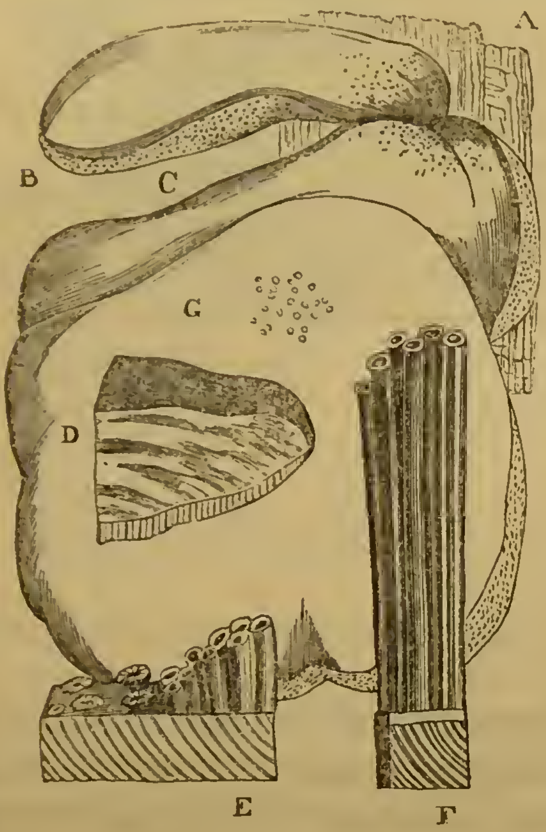
(651.) The subulæ forming the hymenium in these plants, and whence they have been popularly called spine-tools, prickle-stools, &c., are often of considerable length, giving to some a mock-formidable appearance, which, perhaps, led the old herbalists to consider them noxious plants; although there does not in reality seem to be much occasion for Gerard's sarcastic caution, who said, when some continental visitors recommended their use as food,

"I give my advice to those that love such strange and new fangled meats, to beware of licking honey among thorns, lest the sweetness of the one do not countervaile the sharpness and pricking of the other."

Paulet mentions a poisonous *Hydnum*: in general, however, the *Hydnidæ* are innoxious, and several of the genera afford species that are esteemed as food. Those of a dark colour, De Candolle states, are to be more or less suspected. *Hydnum erinaceum* (the hedgehog prickle-stool), which is found growing upon old oaks, forms a common article of food in the Vosges, a range of mountains separating Lorraine from Alsace. *Hyd. corallöides* is eaten in Piedmont and Tuscany, and the *H. Caput Medusæ* in other parts of Italy, under the name of *Fungo istrice*. *H. repandum* is likewise esculent, as are also *H. leonininum*, a native of Sweden; and *H. auriscalpium*, which is indigenous to this country, growing on the cones of fir-trees. *Hydnum album* has somewhat the flavor of the Chantarelle.

(652.) *Fistulina hepatica* (the liver *Fistuline*, or pipe-stool), which is parasitic upon the trunks of old oaks and other trees, is another eatable species, which on the continent is generally esteemed. It is very similar to a piece of bullock's liver; and, when cut into,

it is beautifully marbled with red and white streaks, something resembling a fine piece of beef. In France it is called *Foie de bœuf*, *Langue de bœuf*, *Glue de chêne*; and in Tuscany *Lingua di castagno;* all names indicating a common agreement as to its flesh-like appearance: and it is said, when cooked, to have also an



A. Piece of old oak-bark from which spring

B and C. Two lobes of the liver fungus, Fistulina hepatica.

D. Section of the pileus, to shew the receptacle and hymenium.

E, F. Smaller portions more enlarged, to shew the discrete tubulous subulæ, of which the hymenium is composed.

G. Spores magnified.

animal flavor. It is the only known species in the genus; the old writers on materia medica called it Hypodrys.

(653.) Until lately, *Fistulina*, and many other fungi, were included in a common genus with those species which alone are now considered to be true Boleti. Their differences in structure are, however, so great, that modern science could not allow them to hold a common generic name. For example: in Boletus, the hymenium [§ 655, *c*, *d*,] which is formed of a stratum of connected tubules, is discrete from the receptacle of the pileus; in Fistulina, the hymenium, although discrete, is subulate, the fistulous subulæ being loose, [§ 652, E, F;] while, in the majority of the species, the hymenium is not discrete, but forms a homogeneous stratum with the receptacle, and is simply porous, the pores being sometimes deep, and sometimes very superficial. Fistulina is the name given to the *pipe-stool;* Boletus is retained for the normal species; and

Polyporus lucidus.

(*a*) Entire plant (reduced.)

(*b*) Section of stipes and unilateral pileus.

(*c*) Porous structure of the hymenium.

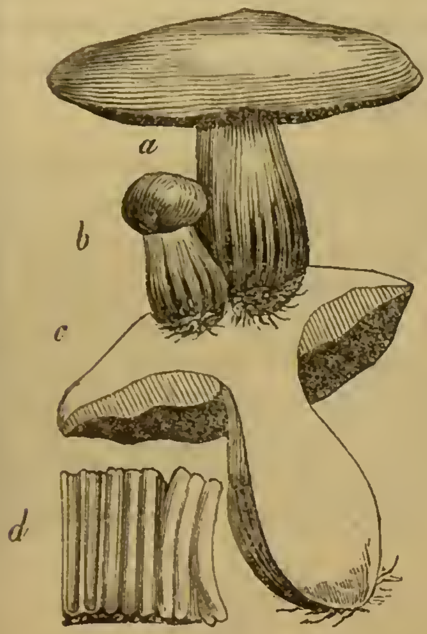
(*d*) Transverse section of the pores, shewing the asci.

those which are punctured, and have many pores, are called Polypori or Polypores.

(654.) *Boletidæ.* De Candolle observes, as a general rule, that the stalks and the flesh of the pilei are edible in the Boletidæ. The following are the exceptions to this rule: 1°, The coriaceous, corky, and woody species. 2°, Those species which have the stipes furnished with a collar, or annulus. 3°, Those which have a peppery flavour; and 4°, Those which become of a blue or greenish colour when cut. This last character is an important one in all the fungi; for it invariably denotes a suspicious quality. The Russians employ those Boleti for dyeing, which change to a blue or green colour when cut.

(655.) *Boletus esculentus, subtomentosus*, and *granulatus*, are all eatable, but not so much esteemed as *Boletus edulis*, which is very common in France, and said, when dressed, to be excellent. In Hungary a soup made from this Boletus is considered a delicacy. *Boletus scaber* is a favourite food among the Russians and Poles, who, as Sowerby was informed, have many ways of cooking and pickling it. Several other species are also eaten on the continent, such as *B. æreus* and *chrysenteron;* the latter of which De Candolle states to be wholesome when young, but to become

noxious, or at least suspected, when mature. *Boletus luridus*, the most splendid species in the whole genus, is at the same time the most deleterious: it is one of our most poisonous fungi. *Boletus*



Boletus luridus.

(*a*, *b*) Entire plants, of different ages.

(*c*) Section, to shew the extent of hymenium.

(*d*) To illustrate the arrangement of the tubes.

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purgans, the old *B. laricis*, has been recommended as a cathartic; its action is violent, and it is seldom, if ever, used.

(666.) Although, in different countries, several species of Polypore are considered alimentary, and one very highly esteemed, they are not, in general, enumerated amongst the esculent fungi; the majority, if not absolutely poisonous, affording unwholesome food. Indeed, *Polyporus squamosus*, which is said by Wulfen to be eaten in Carinthia, and which in France is called *Miellin*, *Langou*, *Oreille d'orme*, &c., has several times proved injurious to those who have partaken of it. *P. frondosus* emits an odour, which, if the fungus be kept in a close chamber, is highly dangerous, as Bulliard experienced in his own person; and, although it is eaten in Piedmont, long exposure to heat, and a tedious process of cookery, are essentially requisite to lessen or remove its noxious properties.

(667.) De Candolle gives the following rule as diagnostic between the harmless and poisonous polypores. The sessile species, or those having lateral pedicles, *i. e.* the pilei springing from one side of the stipes only, are to be suspected, for most of them are

venomous; while those which have a central stipes are harmless, and some of them eatable.

The before-named celebrated botanist has cited the P. squamosus and P. frondosus, both of which have lateral pilei, as exceptions to his rule; but they seem rather to be confirmatory of it [vide § 666]; and, furthermore, the celebrated P. tuberaster, which abounds in the Neapolitan and Papal states, and two other species, which Micheli says are eaten in Tuscany, all have central stalks.

(668.) Several of the Polypori are possessed of more or less important medicinal virtues. *Polyporus igniarius* has long been famed as a styptic; *P. annosus* is reported by the Swedish peasantry to be a cure for snake-bites; and *P. officinalis* is enumerated by the Germans as one of the articles in their extensive list of vegetable medicines: its action is cathartic. Amadou, or German tinder, is made from the *P. igniarius*, by separating the porous hymenium from the harder parts, and steeping it in a solution of nitre, after it has been beaten into a soft and spongy state. Various other species of Polyporus, besides the igniarius, as the *hispidus*, &c., retain fire when dry, and are also collected and used as amadou. The Laplanders have long been in the habit of employing these, and other fungi, for

Polyporus officinalis.

A. Two Polypori growing together, and reversed, to shew the inferior porous hymenia. B. Section, to shew the receptacle and pores. C. Transverse section of pores, shewing the numerous asci. D. Entire plant, front view.

the same purposes, and in a similar way, as the natives of Japan and China do the moxa. Whenever they suffer from pains in their limbs, they bruise some of the dried fungus, or amadou, and, pulling it to pieces, put a small heap of it on the part nearest to the seat of the pain. It is then set on fire, and, burning away, it blisters the skin; and, although some persons may think it a coarse and rough method of treatment, it is generally a very successful one. *Polyporus suaveolens* has a smell like that of aniseed, and it is one of the few luxuries of Lapland. Linnæus says that the odour is there so much admired, that the young men carry it about them when they visit their mistresses, in order to render themselves more agreeable.

(669.) It is not unlikely that other species of Polypore may possess useful properties, or might be resorted to as the sources of valuable drugs. From *P. dryadeus* (the old *Boletus pseudo-ignarius*), Braconnet obtained his boletic, and from *P. squamosus* his fungic acid; and from *P. sulphureus* Dr. Scot, of Dublin, and Drs. Greville and Thompson, of Edinburgh, have procured oxalic acid and bin-oxalate of potash. Mr. Purton had previously noticed the pungent acid taste of this fungus, and especially of the porous part; and I once found an enormous mass of it, like that described by Dr. Greville, on an old willow-trunk in Kensington Gardens, which, while drying, became covered thickly, as if frosted over with a white salt, the bin-oxalate of potash, some of which, with part of the fungus, I now have by me.

(670.) *Polyporus lucidus* [§ 653,] is one of the most elegant species known. It is of so bright a colour, and so highly polished, that Mr. Curtis says, when he first discovered a magnificent specimen growing near Peckham, he scarcely knew whether he had found a natural or an artificial production.

(671.) *Polyporus squamosus*, already mentioned, [§ 666,) is one of the largest of the British fungi, equalling, and often exceeding in dimensions, the gigantic Bovista. Hopkirk has mentioned one, of which the growth was watched for six weeks, that attained an uncommon size. It measured seven feet five inches in circumference, and weighed thirty-four pounds, after it had been cut four days. It must therefore have gained nearly a pound and a quarter every twenty-four hours; and, if allowance be made for the four days' waste of substance, its increase must have been much more.

As these fungi are very common on the continent, they may probably be those to which reference is made with wonder by some of the older writers. Matthiolus mentions some extraordinary mushrooms, that weighed thirty pounds a-piece. Festus Imperatus declares that he had seen some that weighed upwards of one hundred pounds a-piece. But, to add no more, in the Journal des Sçavans there is an account placed on record of some growing on the frontiers of Hungary, which made a full cartload.

(672.) *Polyporus destructor* is one of the fungi included in the incongruous group commonly called dry-rots. Many of these agree in no other circumstance than that of their formidable power of destroying timber; and to wooden structures they are most fearful visitants.

(673.) *Merulidæ.* Similar names have not unfrequently been given to animals and plants, which make their appearance, or come to perfection, at the same season of the year. Thus, the appearance of the young fig and the cuckoo being synchronous in Greece, one and the same appellation (κοκκυξ) was given to both. In Turkey, *Bulbul* signifies both the rose and the nightingale; and *Merulius* and *Merula* are two scarcely differing terms, used, in like manner, by the Romans, to designate an eatable fungus and a blackbird, *i. e.* our *Morel* and *Merle.*

(674.) But, like many other ancient names, *Merulius* has long ceased to belong to the *Morel,* which by modern botanists is called *Morchella,* [§ 638;] and the present *Merulii* are the most formidable of the dry-rots; one species, more common and destructive than the rest, being termed emphatically THE *dry-rot. M. lachrymans,* the species referred to, is extremely variable in its appearance, often resembling a fine cottony Byssus. The fructification is rarely developed: when perfect, the sinuosities of the hymenium are not excelled in beauty by any work, either of art or nature. One of the finest specimens I have seen was discovered in the Duke of Norfolk's conservatory, and presented to the museum in King's College. Had it not been declared that the specific name *lachrymans* has reference to the drops of clear water with which the sinuosities of the hymenium are filled, it might have been supposed to be descriptive of the state of one whose property has been attacked by the Merulius.

(675.) *Dry-rot,* its causes, effects, and modes of prevention or cure, have long excited the attention not only of naturalists, but of the world at large. Indeed, the ravages which the *Merulii,* and other associated fungi, commit in ships, and every kind of wooden structure, as soon as a settlement is made, can be alone conceived by those who have witnessed and examined them. Without having seen vessels and houses in which these destroyers riot, no one can appreciate the ruin they entail. I knew a house into which the rot gained admittance, and which, during the time we rented it, (only four years,) had the parlours twice wainscotted, and a new flight of stairs; the dry-rot having rendered it unsafe to go from the groundfloor to the bedrooms. Every care was taken to remove the decayed timbers when the new work was done, yet the dry-rot so rapidly gained strength, that the house was ultimately pulled down. Some of my books which suffered least, and which I still retain, bear mournful impressions of its ruthless hand; others were so much affected, that the leaves resembled tinder, and, when the volumes were opened, fell out in dust or fragments.

(676.) Writers on naval architecture and on naval affairs record numerous instances of far more extensive and lamentable devastations. In the Quarterly

Reviews for 1812 and 1813 are some very able papers on this subject, from which the following cases are taken. The *Queen Charlotte*, a first-rate, which occupied seven years in building, was launched at Deptford in 1810, and sent round to Plymouth under jury-masts in 1811; and in 1812, when the account was written, she was found to be too rotten to be seaworthy, and was then undergoing a repair which, at the lowest computation, would cost 20,000*l*. Another ship, the *Rodney*, which was launched in 1809, had scarcely put to sea, when all her fastenings became loose, and she was obliged to be brought home from the Mediterranean in 1812, to be paid off. The *Dublin*, also, which was launched in February 1812, and put into commission the following August, affords another equally lamentable proof of the devastating effects of dry-rot. This ship was sent on a cruise towards Madeira in December of the same year, from which she returned to Plymouth, in 1813, in so dreadful a state that she was ordered to be paid off. Cases have been mentioned in which ships have rotted on the stocks, and been obliged to be repaired, even before they were launched; and in private dockyards numerous instances have occurred of vessels which had scarcely been at sea before they were knocked up, and sold for firewood: nor are such cases to be wondered at, when it is known that timber, while stacked for seasoning, which by the ordinary method requires four or five years, has gone to decay before it could be brought into use.

(677.) Some years ago, I examined this subject with considerable attention, and published the results of some experiments in Brande's Journal of Science. These researches led to the belief that rot and dry-rot, although very different, often owe their origin to nearly the same causes; *i.e.* that immature and ill-seasoned wood, and timber felled when the sap abounds, is the most liable to fall into ordinary decay; and that such timber is also most obnoxious to the attacks of those fungi which constitute dry-rot; the crude sap and half-elaborated contents of the ligneous cellules forming the very soil on which such parasites love to grow.

(678.) Seasoning is the means resorted to in order to convert the immature heartwood of trees felled too early, or the perishable sapwood into enduring timber. Barking the trees for a year or two before they are felled, is one plan that has been proposed; submerging the timber, or steeping it in various lyes, are other schemes; but the most common method is to stack the wood in such a manner that it may be freely exposed for four or five years to currents of air, while it is protected from the wet.

(679.) Lately another process has been introduced by Mr. Kyan. He steeps the timber in an aqueous solution of corrosive sublimate; and it is found that this salt, by entering into a chemical combination with the perishable juice of the plant, converts it into a substance upon which the dry-rot fungi cannot grow; and experiments have shewn that timber thus prepared has remained sound and unaffected under the most trying circumstances, in the fungus-pit in Woolwich dockyard, when pieces of similar timber, but unprepared, were speedily consumed.

The sublimate solution is found to be an equally effectual preservative to cords, cables, canvass, linen and cotton cloths, and other vegetable fabrics.

(680.) It had previously been observed that wooden vessels, in which metallic solutions of various kinds were kept, or which were used by the manufacturers of

metallic pigments, became almost imperishable; but Mr. Kyan was the first person who took advantage of this property, and rendered it economically important. It is the opinion of Professor Faraday, that the corrosive (or rather the anti-corrosive) sublimate forms so fixed and unchangeable a body with the vegetable matter, that it will not be washed out, or rise in vapour, so as to form an injurious atmosphere. He does not, however, say anything about the probability of this new combination becoming decomposed by the ordinary influences to which timber in ships, &c. is exposed; although he has proved that the mercury may be separated and reduced to its metallic state by means of nitric acid. Whether the bilge water and foul air in ships would not turn the linen and cotton cloths black, and the sulphuretted hydrogen, in such an atmosphere, reduce the quicksilver, are problems as yet unsolved. We know it to be the opinion of an eminent chemist that they would: and if so, as this gentleman says, in a note on Mr. Kyan's pamphlet, now before me, "its preserving efficacy and salubrity may be justly questioned." And when we consider that five or six thousand loads of timber are required for the construction of a first-rate vessel, it is of the utmost importance to determine whether such mercurialized ships might not, under certain circumstances, in a hot climate, become as unhealthy as the mines of Istria.

(681.) Several topics of inquiry here suggest themselves; for two of which even the commanding interest of the subject can but just claim mention. The first is, whether other less noxious metals may not prove equally efficient as preservatives of vegetable matter with the salts of quicksilver. Our friend already alluded to believes, from the casual observations of many years, that they would. And it might likewise be worth trying, whether some of the cheap essential oils would not be equally preservatives of large masses of vegetable matter from the attacks of the larger fungi which constitute dry-rot, as it is well known the odoriferous and more costly oils, and various other agreeable perfumes, are useful in exempting specimens in herbaria, and indeed almost everything else in the neighbourhood, from the attacks of the smaller fungi, which constitute mouldiness or mildew.

(682. *Dædalea* (the *labyrinth*, or *maze-wort*), has received its name from the extraordinary sinuosities of its hymenium, which seem as if they could have been arranged by Dædalean art alone. The quercine species is the famed agaric of the oak: it is slightly styptic, and, when cut in slices, has been applied to wounds in order to restrain hemorrhage. When dried and powdered, it is sometimes taken in the form of an electuary in phthisis. It has by some persons been much commended: the dose is from a scruple to a drachm. Perhaps part of its reputation may be owing to its provincial name; for what can be so good in a consumption as "the lungs of an oak." It may be bought in Covent Garden; but must be asked for by its country title, as by that only is it known.

Dædalea suaveolens is fragrant, and is used by the young Lap-

landers as a perfume, on the same interesting occasions, and for the same purpose, as the *Polyporus suaveolens* [§ 668.] It also, as well as the *D. quercina*, is administered in pectoral complaints.

(683.) AGARICACEÆ. *Agaricus*, which gives name to this type and section, includes now more known species of fungi than any other genus. *Boletus*, however, seems to have been formerly the more comprehensive term, signifying almost any field mushroom or toadstool; while Agaricus was peculiarly applied to the Sarmatian fungi, which are said to have chiefly, if not exclusively, grown on trees. Thus, the ancient Boletus, 'Fungorum princeps et dominus,' is the present Agaricus cæsareus, and the Dædalea quercina is still called the agaric of the oak. Hence, although Agaricus gives its name to the section, Boletus, as of right, denominates the order.

(684.) *Agaricus* (the mushroom or toadstool), and *Cantharellus* (the chantarelle), are the two best known genera in the type. Cantharellus, and its immediate allies, in which the lamellæ or plates of the hymenium are often cleft and irregular, and occasionally anastamosing and contorted, may be considered as transitions from the sinuous *Boletidæ* to the great group of Agarici, in which the lamellæ are entire. Were these two series to be esteemed subtypes, further and more important distinctive characters might be given; for, while in the *Cantharellidæ* the lamellæ are concrete, with a mostly coriaceous pileus, in the *Agaricidæ* the lamellæ are subdiscrete, and the pileus fleshy.

(685.) The Agaricaceæ are distinguished from the only two other types in this section, by having their hymenia lamellate or plaited; for, in the *Boletaceæ* the hymenia are sinuate, porous, or subulate, and in the *Auriculariaceæ* tuberculate, papillose, or smooth.

(686.) *Favolus* (the honey-comb fungus), placed by Fries in the first division of the *Agaricaceæ*, has usually been arranged as an associate of the Polypores; indeed, as one of the subgenera of *Polyporus*: *Cantharellus* was also once considered a *Merulius*. These therefore, with their allies, *Xerotes* and *Schizophyllum*, which is acknowledged to be aberrant, establish here, as elsewhere, the connexion of the types, notwithstanding their characteristic differences, which are only progressive gradations of structure.

(687.) One species of the Chanturelle, the C. aurantiacus, is said to be delete-

rious; another, the C. cibarius, is much esteemed on the continent as food, and in some parts the people are reported to subsist almost entirely upon it: hence its name *Escraville,* a corruption of *Esca villæ* (village food.) It is occasionally used in the south of England, but never in the north; where, however, according to Johnston, it is by no means common. Chantarelles, the yellow fungi, or Pixy stools, of our provinces, are rather tough, and seem to be better fitted for flavouring sauces than to be eaten alone. They are scentless when quite fresh, but, shortly after being gathered, they exhale a pleasant odour, like that of ripe apricots; and, when they have become flaccid, they are usually strung in rows, and hung in an airy place to dry. Thus preserved, they are ready for use at any time, and form a delicious ingredient in rich gravies, &c.

(688.) The Chantarelle was so called by the French, from a fancied resemblance the eatable species bears to the head and open beak of a cock in the act of crowing; and, as Greville says, to the same cause may be traced the still older name of Gallinaceus. Indeed, few fungi possess so many synonymes; their bare enumeration nearly fills a closely printed page in the Cryptogamic Flora. Like various other mushrooms, it is injurious if eaten raw, but becomes harmless by drying, or by exposure to heat.

Mushrooms of all kinds, and especially the *Boletaceæ* and *Agaricaceæ,* should be gathered for the table before their full development, as many then become tough, others insipid, and some, which are wholesome when young, are deleterious at a later age. Experience has shewn that in such cases, as well as in fungi commonly reputed hurtful, it often happens that the hymenium alone is noxious, while the rest of the plant is unexceptionable. The hymenium should therefore invariably be removed when it is tubular, and even in the agarics when they are old. Specimens beginning to decay, as well as those which have been partly consumed by vermin, should also be rejected.

(689.) The genus Agaricus is believed to contain upwards of a thousand different species. Sprengel enumerates only 646, but this is much below the number described by other authors. So immense a group imperatively requires subdivison; but, although numerous attempts have been made, so similar are they to each other in the more essential characters, although an infinite diversity is evident in minor points, that it has been found impracticable to do more than distribute them into subgenera; no differences having as yet been found of sufficient importance to be made generic signs.

"Facies non omnibus una,
Nec diversa tamen, qualem decet esse sororum."

(690.) The subdivisions of the genus proposed by Fries amount to eight, which eight groups are again distributed into thirty-three subgenera, all of which are distinguished by structural peculiarities; so that the labour of examination is very much diminished, and comparisons may now be made in these with as much facility as in other groups of plants. It would be a pleasing task to trace the steps by which this more than Briarean genus, that stretches its species by hundreds on every side, has been reduced by botanic skill to the simplest state. But, however fitted for a *Species* or *Genera* Plantarum, this digression would be foreign to a work which professes to treat only in outline of the natural history of vegetables, and to illustrate, by reference to the most important examples, the types and sec-

tions of the natural orders. A tabular conspectus of the plan is therefore all that can be admitted here.

AGARICUS. *Lamellæ simple, unequal, juiceless, persistent, discrete from the pileus.*	LEUCOSPORUS. *Lamellæ unchangeable, veil variable or none, sporidia white.*	Amanita Lepiota Limacium Tricholoma Clitocybe Omphalia Collybia Mycena Omphalia Pleurotus
	HYPORHODIUS. *Lamellæ changeable in hue, veil none, sporidia rose-coloured.*	Clitopilus Eccilia Leptonia Nolanea.
	CORTINARIUS. *Lamellæ changeable, veil like a cobweb, sporidia ochraceous.*	Telamonia Phlegmacium Inoloba Dermocybe.
	INOCYBE. *Lamellæ changeable, veil springing longitudinally from the innate fibres of the pileus, sporidia tawny brown.*	Inocybe.
	DERMINUS. *Lamellæ discoloured, veil floccose, sporidia subferruginous.*	Pholiota Hebeloma Flammula Naucoria Galera Tapinia Crepidotus.
	PHŒOTUS. *Lamellæ changeable, nebulous, veil various, sporidia dark brown.*	Pratellarius.
	PRATELLUS. *Lamellæ changeable, lax, nebulous; veil floccose; sporidia brownish purple.*	Volvaria Psalliota Gomphus Hypholoma Psilocybe Psathyra.
	COPRINARIUS. *Veil partial; lamellæ lax, nebulous; sporidia black.*	Coprinarius.

(691.) *Coprinus* (the dung-stool), is a genus separated from Agaricus, and intermediate between it and Cantharellus. Some of the species are European; but they are of too soft a texture, and nauseous a taste, to be eatable: *C. cinereus* is so rapid in its growth and decay, that it attains perfection, and dissolves away, in the course of a few hours. In the Spice Islands, however, there are two species, one of which (*C. saguarius*) inhabits the pith of the sago-palm, and the other (*C. moschocaryanus*) a parasite on the nutmegs, that are said to be delicious.

(692.) *Russula* (the mush-russet), and *Galarheus* (the milk-stool), are names which have been given to two groups of fungi formerly considered agarics, and still by some persons esteemed subgenera of that immense association: by Fries, however, they are accounted generically distinct. The *Galarhei*, which have been so named from the lactescence of many species, are some of them deleterious, and others esculent. *Agaricus* (Galarheus) *necator* and *thejogalus*, which have a yellowish juice, are deadly poisons; *A. vietus, acris, blennius,* and *pyrogalus*, are very acrid; *A. helvus* and *aurantiacus* rather less so, but still hurtful; *A. controversus* and *torminosus* must be considered dangerous, notwithstanding Persoon says the former is eatable, and Buxbaum states that, in times of scarcity, the latter is eaten by the Russians, mixed with salt, vinegar, and oil; *A. subdulcis* is said to be occasionally fed on, and *A. piperatus*, when dressed, to lose its bad taste, and to be esteemed as food in Alsace: *A. deliciosus* is considered a delicacy everywhere. Climate seems to affect this species less than most others. When well dressed, it is described to be "very luscious eating, full of rich gravy, with a little flavour of muscles." When Sir J. E. Smith visited Marseilles, he says "the market exhibited a profusion of spring-flowers, and even carnations, intermixed with grapes, dates, pomegranates, and a prodigious quantity of Agaricus deliciosus, which really deserves its name, being the most delicious mushroom known; though it must be confessed that nothing can be less attractive than its appearance, its colour being a dirty brown, and the juice of a deep orange, soon turning to a livid green, wherever the fungus is touched or bruised."

This subgenus contains fungi both esculent and poisonous, and almost in every grade: it is therefore a very suspicious group; probably the same noxious principle is present in all, though developed in different degrees. It is a curious circumstance, but one which meets with many parallels, that most of the poisonous mushrooms, and particularly those just mentioned, are the favourite food of goats during the rutting season: whether these animals can eat them at other times with impunity, is not known. The juice of the *A. piperatus*, mixed with syrup of marshmallows, is stated by Losel, in his "Flora Prussica," to be a powerful diuretic.

(693.) The *Russulæ* are fungi which owe their subgeneric name to their generally russet hue. Some of them are eatable, as *R.*

alutaceus; while others, as *R. ruber*, *nitidus*, and *emeticus*, are so nauseous, bitter, and acrid, as to be wholly unfit for food.

(694.) [*Coprinarius.*] *Coprinarius*, the first subgenus of the Agarici, contains various fungi that luxuriate on dunghills. None of them are known to be poisonous; neither are any esteemed as food.

(695.) [*Pratelli.*] The subgenus called *Psalliota* contains the common mushroom [§ 600, fig. E, G,] *Agaricus* or *Psalliota campestris*, with several other species that are mostly eatable. The mushroom is indigenous to the whole of Europe, reaching even as far north as Lapland; it is likewise found as far south as Japan in Asia, and in the northern parts of Africa and America. The *Agaricus Georgii*, which by some is considered only a variety of the foregoing, is a larger mushroom, but its flavour is less delicate. When cultivated, it often attains an immense size. Dr. Withering mentions one gathered from a hotbed near Birmingham that weighed fourteen pounds.

Even these mushrooms, which of all are the least suspected of containing any deleterious principles, are occasionally found to be injurious. Most of the cases of poisoning by mushrooms are, however, owing to other species being gathered by mistake; quantity, rather than quality, seeming to be the object of those who collect them. Dr. Christison says, "I have seen those who gather mushrooms near Edinburgh, for the purpose of making ketchup, picking up every fungus that came in their way." Fatal accidents from such carelessness or ignorance would doubtless be much more frequent than they are, if the poisonous properties of many fungi were not dissipated by heat; and the spices with which they are mixed in cookery are the best antidotes that could be administered to counteract their injurious effects.

(696.) [*Dermini.*] The *Agaricus translucens* (in Fries, subgenus *Crepidotus*), is said by De Candolle to be eaten by the poor people of Montpelier: it is, however, a watery mushroom, and must form very indifferent food. *Agaricus* (*Crepidotus*) *olearius*, which grows on the olive-trees of the south of Europe, is poisonous. It is remarkable for being phosphorescent, and exhibiting a luminous appearance at night.

(697.) [*Inocybe.*] The subgenus Inocybe is a solitary one, like Coprinarius and Phæotus. It contains several fungi differing considerably from the other groups by their fibrous veils. Their nauseous odour renders them unfit for food; but, although suspected, they are not known to have deleterious properties.

(698.) [*Cortinarii.*] Agaricus (or Dermocybe) cinnamomeus, is another eatable species. Those fungi which, from their gigantic stature, have received the figurative subgeneric name *Telamonia*, are none of them eaten; but *Agaricus* (or *Inoloma*) *violaceus* is much esteemed. When well broiled and duly seasoned, it is said to be as delicious as an oyster. It is not uncommon in the woods near Bath and Worcester, during the latter part of the autumn; and is sometimes sold in Covent Garden under the name of Blewits.

(699.) [*Hyporhodii.*] *Nolanea* (the bell-stool), *Leptonia* (the slight-stool), and the other subgenera included amongst the *Hyporhodii*, are inodorous, insipid, innoxious plants, but watery and unfit for food.

(700.) [*Leucosporii.*] The subgenus *Pleurotus* contains a group of innoxious fungi, several of which are esculent; as *A. ostreatus*, *ulmarius*, &c., some of these attain a prodigious size; but they are rarely used in England. Sowerby mentions having seen the latter species two, or even three, feet in circumference, so that, had not prejudice forbidden, half-a-dozen men or more might have made a hearty and a wholesome meal from a single mushroom.

(701.) *Agaricus* (or *Collybia*) *esculentus*, *A.* (or *Clitocybe*) *fusipes*, *nebularis*, *virgineus*, *odorus*, *pratensis*, and *oreades*, are all eatable species, and more or less esteemed by different persons. The last named are called *Scotch-bonnets* in the north. C. pratensis is often collected in the western counties, and called champignon; C. odorus has a peculiarly pleasant smell, like woodrough, or new-mown hay, and hence it probably contains benzoic acid.

Several Agarics, amongst which are two species of this subgenus, viz. *C. oreades* and *giganteus*, affect a peculiar mode of growth, always being found in circles, the diameters of which are, however, very various: Major Velley mentions having seen some formed by A. terreus, from ten to fifteen yards across. "These *fairy rings*, so common on our grassy links and old pastures, where

of old the merry elves were seen,
Pacing with printless feet the dewy green;"

were, when this land was "fulfilled of faerie," believed to be the result of their midnight reels, and hence they have been called fairy rings, as the Chanterelles, on which the *Pixies* were supposed to rest, received the name of Picksey-stools. But now, as Johnston says, when no man can 'see no elves mo,' another explanation of the phenomenon has become necessary. Several have been offered, but only two that possess much semblance of truth. The first of these considers them the results of electrical discharges. Dr. Darwin states this argument with his usual ingenuity. He says, moist trees are the most common conductors of the numerous flashes of lightning which pass from the clouds to the earth, and much timber is thereby cracked and injured, but frequently large prominences of

the clouds, gradually sinking, their electricity is discharged on knolls, or the moister parts of grassy plains. Now a corner of a cloud thus attracted by the earth becomes nearly cylindrical, as loose wool does when drawn out into a thread, and it will strike the earth with a stream of electricity perhaps two, or perhaps ten, yards in diameter. As a stream of electricity displaces the air it passes through, it is plain no part of the grass can be burned by it, but just the external ring of the cylinder where the grass can have access to the air, since without air nothing can be calcined. The earth, after having been thus calcined, becomes a richer soil, and either fungi, or a bluer and richer herbage, will, for many years, mark the place. There are many circles of several yards in diameter near Foremark, in Derbyshire, which annually produce large white fungi and stronger grass, and have done so, it is said, for upwards of thirty years.

Electrical discharges may be one cause of the production of fairy rings; but that they are not the only cause seems probable, from the fact that never more than one species of mushroom has been detected in the same ring, which circumstance has been deemed conclusive by many that fairy rings owe their existence to Agarics. This belief led Dr. Withering to seek another cause; and he has offered the following explanation. A tuft of Agarics spring up, which, exhausting the soil on which they grow, the succeeding crop would necessarily form a circle round the central spot from which the primary tuft had withdrawn its nutriment. The first circle being thus produced, circles successively larger and larger would annually be formed, until at length they were interrupted by accident, or lost by their extent. For fungi, like other plants, seem to exhaust the soil of some peculiar nourishment fitted for *their* growth, although sufficient food may be left for the support of other plants; this being merely an example of the natural rotation of crops, which, since it has been observed and adopted by farmers, has proved so great a benefit. A luxuriant growth of grass would follow the decay of each agaric ring as the natural consequence of the circle being enriched by the rotting fungi; new crops of which, of course, would travel outwards, stretching into the unexhausted soil. Subsequent observation appears to confirm this view; nor is it weakened by the observation of Major Velley, who states, that if a cluster of the Ag. terreus be destroyed, another will in a short time spring up on the *same* spot, and if that be crushed, it will be succeeded by a third. These facts only prove that the first and second were destroyed *before* they had exhausted the soil, which hence was able to support another generation.

And thus hath philosophy withdrawn their occupation from all those

—— "demi-puppets that
By moonshine did the green sour ringlets make
Whereof the ewe not bites; and those whose pastime
Was to make the midnight mushrooms."

(702.) Several of the species of the subgenus *Tricholoma* are eatable, but one only, the *T. Russula*, is much esteemed. Of the *Limacia* several are noxious; but one species, *L. eburneum*, is eaten in Italy under the name of *Mugnaio*. The *Lepiotæ*, or scaly mushrooms, are some of them fœtid and unfit for food, and others are insipid and worthless: two or three species, however, are frequently eaten even in this country, where fewer fungi are admitted to the table than in almost any other. *Agaricus* (*Lepiota*) *excoriatus* and *procerus*, are both edible; the latter sometimes makes its appearance in Covent Garden market; and throughout the whole of France and Italy it is an ordinary article of diet: it has various foreign names, amongst which the more common are *Mort de froid*, *Mazza di tamburo*, and *Nez de chat*.

(703.) The *Amanitæ* afford examples of some of the most splendid fungi known. To use the language of our neighbours, *A. imperialis* is magnificent, but *A. cæsarea* is superb. The latter is the plant, already mentioned, as having been styled by the ancients *Fungorum princeps* et *Dominus;* and none could better deserve the name.

Withering believed the *A. cæsarea* and *xerampelina* to be one, or merely varieties, of the same species. From this opinion, however, Dr. Greville dissents. From a mere verbal description of this Agaric, it is evident that its appearance must be rich in the extreme. The stipes is columnar, slightly tapering upwards, about five inches high and half an inch in diameter, of a rich buff colour shaded with red; the pileus is about twelve inches round, convex, and bossed in the centre, with the circumference bent down. The upper surface is at first of a beautiful carmine, which changes after a time to a rich orange, and ultimately becomes buff; the hymenium is of a bright golden yellow, tending to orange at the extremities of the gills, where they meet the red tunic of the pileus.

(704.) The A. cæsarea is a fungus possessed of some classic fame; it has been celebrated both by Juvenal and Martial; not so much, however, for its beauty, as for the traditional belief that it was in a dish of these mushrooms, which by the ancient Romans were considered the greatest luxuries of the table, that Agrippina administered poison to her husband, Claudius Cæsar, to hasten her son's accession to the throne. Hence probably it derived its specific name *Cæsarea*; but Nero, for whose sake Claudius had been poisoned, called it the *food for gods,* because, after his death, Claudius was numbered amongst the Roman deities.

(705.) It appears, from Pliny, that, after the murder of Claudius, mushrooms fell into unmerited disrepute. He says, "Among all those things which are eaten with danger, I take it that mushrooms may be justly ranged in the first and principal place: true it is they have a most pleasant and delicate taste; but discredited much they are, and brought into an ill name, by occasion of the poison which Agrippina, the empress, conveyed unto her husband the emperor by their means: a dangerous precedent given for the like practice afterwards." (*Holland's Trans.*) The A. cæsarea has, however, through the lapse of time, again recovered its reputation, for now it is commonly seen in the Italian markets; in Italy it is abundant, but in these kingdoms rare. It is liable to be mistaken for a poisonous species belonging to the same subgenus, but may easily be distinguished by its yellow gills from the A. imperialis, in which they are always white.

(706.) *Amanita nivalis,* which Dr. Greville says is the most alpine fungus he is acquainted with, and which grows on the bleak summits of the Grampians, enlivening by its symmetry and extreme whiteness the few turfy spots that occur in those desert regions, is found also in Italy, according to De Candolle, who quotes from Michelli, and says that it is eaten by the Tuscans, and by them called *Fungo marzuolo,* or *dormiente. Amanita ovöidea* is also said to be delicious; and A. vaginata is fed upon by the poor in Muscovy: but cases are on record in which it has proved poisonous.

(707.) The *Amanita imperialis* [§ 600, fig. A, B], has long been notorious for its intoxicating and poisonous properties. It has sometimes been eaten by mis-

take, and the results have proved fatal. Linnæus tell us that in Denmark the natives cut it in pieces, which they steep in milk, and it then proves as destructive to flies as arsenic; hence it has received its present specific name, *Muscaria*. Dr. Johnston corroborates this fact, by stating that he has observed flies which sip the dirty yellow liquor into which the Amanita dissolves die almost immediately. Haller mentions the cases of six Lithuanians, who perished at one time by eating this Amanita. And Christison, among other instances, relates those of four French soldiers, who were killed, and others who were much disordered, by a similar fatal repast. Orfila likewise records similar examples of its virulence, in one of which a whole family was poisoned and, although some were recovered by speedy remedies, two died. The Amanita is nevertheless employed by the Ostiacks of Siberia, the Kamtschatdales, and Koriacks, for the purpose of producing intoxication. These infatuated people "sometimes eat it dry, sometimes immersed in a fermented liquor made with the epilobium, which they drink, notwithstanding the dreadful effects that inevitably follow. At first they are seized with convulsions in all their limbs, then with a raving, such as attends a burning fever; a thousand phantoms, gay or gloomy, according to their constitutions, present themselves to their imaginations; some dance, others are seized with unspeakable horrors. They personify this mushroom; and if its effects urge them to suicide, or any dreadful crime, they say they obey its commands. To fit themselves for premeditated assassinations, they take the *Mouchomore*, the Russian name of this Agaric; and, such is the fascination of drunkenness in this country, that nothing can induce the natives to forbear this dreadful poison." (*Pennant.*)

(708.) The most complete and satisfactory account of this fungus, and its extraordinary effects, which has yet been published, will be found in a German essay, by Dr. Langsdorf, in *Annalen der Wetterauischen Gesellsrchaft für die gesammte Naturkunde*. This essay has been quoted by Dr. Greville, in his treatise on the esculent Fungi of Great Britain, and from his translation the following are extracts.

"The variety of *Amanita muscaria*, called *Kamtschatica*, is used by the inhabitants of the north-eastern parts of Asia in the same manner as wine, brandy, arrack, opium, &c. are by other nations. These fungi are found most plentifully about Wischna, Kamtschatka, and Mitkowe Derewna, and are very abundant in some seasons, and scarce in others. They are collected in the hottest months, and hung up by a string in the air to dry; some dry of themselves on the ground, and are said to be far more narcotic than those artificially preserved. Small deep-coloured specimens, thickly covered with warts, are also said to be more powerful than those of a larger size and paler colour. The usual mode of taking the fungus, is to roll it up like a bolus, and swallow it without chewing, which the Kamtschatdales say would disorder the stomach. It is sometimes eaten fresh in soups and sauces, and then loses much of its intoxicating property; when steeped in the juice of the berries of *Vaccinium uliginosum*, its effects are similar to those of strong wine.

"One large, or two small fungi, is a common dose to produce a pleasant intoxication for a whole day, particularly if water be drank after it, which augments the narcotic effect. The desired effect comes on from one to two hours after taking the fungus, in the same manner as from wine or spirits: cheerful emotions of the mind are first produced; the countenance becomes flushed; involuntary words

and actions follow, and sometimes, at last, an entire loss of consciousness. It renders some remarkably active, and proves highly stimulant to muscular exertion: with too large a dose, violent spasmodic actions are produced.

"So very exciting to the nervous system, in many individuals, is this fungus, that the effects are often extremely ludicrous. If a person, under its influence, wishes to step over a straw or a small stick, he takes a stride or a jump sufficient to clear the trunk of a tree; a talkative person cannot keep silence or secrets; and one fond of music is perpetually singing.

"The most singular effect of the *Amanita*, is the influence it possesses over the urine. It is said that, from time immemorial, the inhabitants have known that the fungus imparts an intoxicating quality to that secretion, which continues for a considerable time after taking it. For instance, a man moderately intoxicated to-day, will by the next morning have slept himself sober; but (as is the custom) by taking a teacup of his urine, he becomes more powerfully intoxicated than he was the preceding day by the direct administration of the fungus. This intoxicating property of the urine is capable of being propagated; for every one who partakes of it has his urine similarly affected. Thus, with a very few *Amanitæ*, a party of drunkards may keep up their debauch for a week. Dr. Langsdorf mentions, that by means of a second person taking the urine of the first, a third of the second, and so on, the intoxication may be propagated through five individuals."

(709.) Like many other poisonous plants, this fungus, which possesses such extraordinary powers, might, if judiciously administered, become a serviceable medicine. Less attention has been paid to it than it deserves. It has, however, been exhibited in epilepsy and palsy, and, it is said, with satisfactory results.

(710.) The *Amanites* form the last of the numerous subgenera that the genus *Agaricus* includes, and with the foregoing accounts of the *Agarici*, the illustrations of the type *Agaricaceæ* is closed. The *Agaricaceæ* terminate the section *Agaricinæ*, which is the final one in the order Boletales; and the order *Boletales* being thus concluded, the illustrations of the class are at an end. It therefore only now remains to give the usual tabular conspectus of the distribution of the order last examined, with references to those sections, in which definitions will be found of the several groups.

Order.	Sections.	Types.
BOLETALES, OR MYCETALES.	Agaricinæ (642)	*Agaricaceæ* (682)
		Boletaceæ (648)
		Auriculariaceæ (644)
	Helvellinæ (639)	*Helvellaceæ* (634)
		Pezizaceæ (628)
		Clavariaceæ (617)
	Tremellinæ (612)	*Cyphellaceæ* (611)
		Exidiaceæ (609)
		Tremellaceæ (608).

(711.) Botanical characters, which in general indicate the properties of plants by shewing the affinities of unknown species with those the qualities of which are known, have long been considered to fail in their application to the fungi: and this group has often been cited as a reproach to the natural system of arrangement. But the previous demonstrations will have shewn that the reproach has been, if not unmerited, at least premature; for the fungi, instead of forming but *one* group or natural family, as they were esteemed by Ray, Linnæus, Jussieu, and even by many living writers, are shewn to include many types and sections, equivalent to the groups, called natural families and orders by different botanists, and to form collectively a group, not analogous to the subordinate families or orders *Rosaceæ*, *Solaneæ*, &c., but a class equal in rank either to the glumaceous, or petalöid monocotyledons; the gymnospermous or angiospermous Exogenæ; *i. e.* to the Segetes or Palmares; the Zapini, Eucarpæ, or Selanthi. Such being the case, it will be evident that, although the fungi are some of them highly acrid and venomous, others esculent, and others inert, these differences are no greater than what occur in most other classes of equal rank and magnitude; the homogeneity which attends homomorphism, *i. e.* the similarity of quality which in general is associated with similarity of form, in the majority of cases not extending to larger groups than are here called types and sections, by whatever variety of names they may be distinguished by various authors.

(712.) Many errors seem to have been adopted with regard to the pretensions and objects of the so-called natural scheme; one more of which needs, here, correction. The natural synthesis does not pretend always to associate plants of similar qualities and properties; but, as far as knowledge permits, to associate those which are structurally allied. In thus doing, it is found that certain groups, having similar forms, have similar qualities; *i. e.* are both homomorphous and homogeneous; while those which are essentially unlike in structure, are unlike in properties also; *i. e.* being heteromorphous, they are in general heterogeneous.

(713.) This doctrine, of the analogy existing between internal properties and external forms, is one of the most valuable in the science, but it has been frequently abused; less, however, by its opponents than its supporters, who have often injudiciously endea-

voured to convert a general into a universal rule, when both experience and experiments shew that some plants, naturally associated by structure, possess very diverse properties, some differing in degree, and others essentially in kind. Still the natural system is not the less useful when it points out the suspicious groups, than when it indicates those which are uniformly poisonous or wholesome.*

(714.) But the fungi have often been said to deviate more from this analogy than most other plants; and the statement in some measure is correct, yet it requires considerable qualification; for, while some groups are invariably sane, and others noxious, others again have their qualities affected by soil and climate to an extent which, if not wholly without a parallel, is comparatively rare among other plants.

(715.) These apparent anomalies, occurring in several of the most common and familiar species, have led some persons to believe the fungi, in general, to be irreducible to those laws which prevail in other natural groups of plants. And this error was fostered, if not engendered, by the former association of all the fungi in a single natural order, *i. e.* the confusion of many typical groups in one; and which, as they were dissimilar in structure, must necessarily exhibit dissimilar properties also.

(716.) The extent of this confusion will best be seen, by reducing the sections and orders into which the class is now distributed to a tabular form, similar to those conspective tables which have already been given at the conclusion of each order. It should, however, be remembered, that each of the sections contains several *types* which are equivalent to those groups, which are called *orders* by some botanists, and families by others, but which are of equal rank and importance, by whatever names they are known.

* Besides the systematic characters by which the wholesome and hurtful agarics may be distinguished from each other, experience has led to, and experiments have confirmed, the following more popular generalizations. A pure yellow or golden colour denotes a good quality. Many excellent species have a very pale or nearly white pileus, and some are brown. Those with vinous red or violet caps are universally wholesome. But the orange red and rose coloured ones are poisonous. Those which are green, or black, or purple changing to black, are also hurtful. Like the Boleti, those agarics which have unilateral pilei are mostly noxious, as well as those in which either the receptacle of the cap is very thin in proportion to the gills; or in which the lamellæ are all equal in length; or in which the collar is of a thin membrane, like a spider's web. Lactescent and deliquescent agarics, and also such as grow in tufts on trees, are in general to be avoided.

Class.	Orders.	Sections.
FUNGI	Boletales	*Agaricinæ*
		Helvellinæ
		Tremellinæ
	Tuberales	*Tuberinæ*
		Bovistinæ
		Sphærinæ
	Mucedinales	*Tubercularinæ*
		Mucorinæ
		Uredinæ.

(717.) The inevitable tendency of confounding so many groups, which are naturally distinct, was to render the fungi apparently much more anomalous than they really are; and now that the distribution of the class has been improved, many of the supposed deviations have been cancelled, and those which remain are but the exceptions to the rule, as are several which occur in other classes. Thus, the *Tuberaceæ*, the *Clavariaceæ*, and the *Helvellaceæ*, are as homogeneous as the *Malvaceæ*, the *Cruciferæ*, and *Solaneæ;* and the *Boletaceæ* and *Agaricaceæ*, the most abnormal of the whole, are not more so than the *Papilionaceæ*, the *Umbelliferæ*, and *Urticeæ.*

(718.) The malign influence of this error has been no where more sensibly felt than in Britain; for, the fungi being condemned in the gross as deleterious plants, very few have been able to withstand the prejudice raised. Thus, at least, thirty of our indigenous species are esculent, but not more than two or three are eaten; and our paupers starve with food around them which in some continental states is esteemed a luxury, and in others, forms a staple article of diet.

(719.) Greville, upwards of ten years ago, directed public attention to this subject, in a very able memoir, read before the Wernerian Society of Edinburgh; but still "the Fungi are looked down upon with contempt and aversion;" and Great Britain, possessing most of those species that supply a constant resource to thousands on the continent, continues to be the only country in Europe in which they are wasted and despised. In Russia, and throughout the greater part of Europe, the fungi form "a regular article of diet, and not merely as a resource in times of scarcity, but as a delicacy. It is therefore not a little extraordinary, that *we*, who have before our eyes several esteemed species in profusion, should neglect the whole, except the common mushroom, the Truffle, and the Morelle. On the continent it is a common practice to eat various fungi in a raw state, which, it is said, renders them more nutritious. SCHWÆGRICHEN mentions this expressly in a letter quoted by Persoon: "In travelling through Germany and Austria, I observed the peasants in the vicinity of Nuremberg, where I lived part of the summer, to eat raw mushrooms seasoned with anise and carraway seeds along with their black bread. Being then employed on the study of cryptogamous plants, I resolved to try the effect of this kind of food on my own person. I therefore

imitated these people, and succeeded so completely, that during several weeks I ate nothing but bread and raw fungi, and drank nothing but water. Instead of finding my health affected, I rather experienced an increase of strength. I preferred those species which had neither a bad flavor nor a disagreeable smell, and which had a tolerably firm consistence; as *Boletus esculentus*, *B. rufus*, *Agaricus campestris*, *A. procerus*, *Clavaria corallöides*, &c.

"I have observed that fungi, if moderately used, are very nourishing, but that they lose their good qualities by culinary preparation, which deprives them of their natural taste." (PERSOON *Traité sur les Champignons comestibles*. GREVILLE, &c.)

(720.) The opinion of Schwægrichen as regards the effects of cooking, upon fungi, is not consonant with general experience. It is true that many of the innoxious fungi have their flavour impaired by long exposure to heat; and it is probable that they may thus be rendered less nutritious, yet it is also well known that various mushrooms are not only improved by cookery, but that several which are poisonous in a raw state, are innoxious after they are dressed.

(721.) The analyses of fungi which have been made by Braconnot and Letellier are also favorable to their culinary preparation; for, besides the *fungin*, as the bulk of the materials which compose the plants is called, and which appears to be harmless both in the poisonous and wholesome species, these chemists found in some albumen and adipocire, in others saccharine matter, in some peculiar acids, as the *fungic* and *boletic*, in others an acrid resin, and in others an acrid and volatile principle. M. Letellier also discovered in some fungi one, and in others two, peculiar poisonous principles. One of these principles is an acrid matter so very fugacious, that it disappears when the plant is either dried or boiled, or macerated in weak acids, alkalies, or alcohol. To this principle, he says, the irritating properties of some of the fungi are owing. The other principle is more fixed, as it resists drying, boiling, and the action of weak alkalies and acids. It is soluble in water, has neither taste nor smell, and forms crystallizable salts with acids. To this principle he attributes the narcotic properties of some fungi. He has found it in the *Amanita muscaria*, *verna*, and *bulbosa*, and therefore proposes to call it *Amanitine*. Its effects on animals appear to resemble considerably those of opium." (*Arch. Gen. de Med.* xi. 94, *and Christison on Poisons*, 772.)

(722.) The result of these experiments will satisfactorily account for the beneficial effect of heat on some poisonous fungi, and its inefficiency with others; for, those which are rendered deleterious by the presence of the volatile poison only, would, of course, be converted into wholesome food by cookery; while those, in which both are present, or such as the Amanitæ, in which the latter abounds, would still be noxious, notwithstanding their exposure to heat.

(723.) These various principles, which seem to be analogous to those proximate principles upon which the peculiar properties of other plants depend, are not all present in all fungi, but, being variously distributed, and in different degrees developed, confer, with other principles, many of which, as the oxalic acid, &c., have been detected, their peculiar and characteristic qualities upon the numerous genera and species of this very extensive class.

(724.) Fungin, which forms the bulk of all the fungi, is in itself innoxious, and it is a highly nutritious substance; it contains nitrogen, and is very similar in its composition to animal matter. Indeed, so similar as to lead flesh-flies, by an error of instinct, to deposit their eggs in many toadstools. This, in different mushrooms, is of different degrees of density, according to the quantity of water it is joined

with, and acquires different odours, flavours, and properties, according as other principles are added, and according to the degree in which they are evolved.

(725.) In certain situations, truffles, morels, and common mushrooms, are nearly tasteless, while in others, their grateful tastes and smells are highly developed; and in a similar way, certain fungi, which are eatable in one country, or when gathered from one situation, are deleterious when growing in another. This difference depending upon the greater or less quantity of the poisonous matter formed, the production of which may be favored or suppressed by external physical circumstances, just in the same way as celery is said to be poisonous, and sea-kale and asparagus not eatable, when growing wild, but which become bland and esculent when chance or culture, by excluding light, prevents the formation of their acrid principles.

(726.) Before any rational account could be given of these changes, many curious speculations were indulged in, which rather excited than satisfied the curiosity of the ignorant. Fungi, as well as other plants, were formerly believed to be poisoned by the breath of toads and snakes. Pliny gravely asserts that they are very fit objects to retain the venom conveyed by the breath of serpents; and it is thought that the vulgar name, toadstool, which is given to many poisonous mushrooms, has reference to such a belief. Boccaccio furnishes an illustration of the prevalence of the idea; for, in one of his tales, he attributes the death of two lovers to their having put into their mouths sage-leaves plucked from a plant under which there was subsequently discovered a huge toad, whose venomous breath had rendered the sage-leaves poisonous.

(727.) Richard was so convinced of the influence of soil and climate upon fungi, that he would never eat any even of the common mushrooms which had not been cultivated. This, however, was an over-jealous care; for, notwithstanding there have been some few reports of eatable mushrooms proving injurious, they are not more than may fairly be attributed to idiosyncrasy.

(728.) When deleterious fungi have been eaten, the symptoms they produce are in a great measure similar to those which follow the exhibition of other acrid-narcotic poisons: usually the effects are compound, but occasionally, according to the fungus taken, or the state in which it has been eaten, the symptoms are more or less purely those of acrid or of narcotic poisons.

(729.) The spices and the spirit with which fungi are served up to table on the continent are believed often to destroy or neutralize their deleterious powers; and hence their administration has been recommended when poisoning from mushrooms occurs. No especial antidote is known; but, after the offending matter has been dislodged, ammonia and other stimulants may be given, if the narcotism prevails; and bland drinks, with other antiphlogistic remedies, if the irritation predominates, which it often does to a fatal extent.

GEOGRAPHICAL DISTRIBUTION OF THE FUNGI.

(730.) Plants so essentially nomadic as the fungi, plants so peculiarly privileged to wander from place to place, whose general usefulness depends upon their vagrancy, and whose chief importance results from their intermittent and remittent visitations; at one time being present in the utmost profusion in a place where for years or for ever, they had not occurred, and may not occur again; can

scarcely be expected to afford many fixed data as to their topographical localities, or to require much to be said of their geographical distribution.

(731.) Still, meagre as are the materials as yet collected that are available for this department of the study, there are evident indications that, if our knowledge were as extended as the facts are cognizable, the habitats and stations of the fungi would be found to be as relatively definite as are the geographical and topographical ranges of other and higher plants. For parasitic fungi, and even those which are parasitic not on certain species only, or on certain dead or decaying vegetables alone, but also those which flourish upon several or many organic substances, or upon common vegetable mould, and which hence are less dependent upon fortuitous circumstances for their especial soil, appear to affect particular latitudes, and to abound more or less in different regions, and to be wholly absent from various places.

(732.) The little knowledge we possess upon this point already proves that most of the extra-European fungi are distinct from the European kinds; some few of those indigenous to Barbary, and in similar latitudes in North America, are identical with ours, but the majority are specifically distinct. This, which might have been anticipated, is however a fact, that it is important to have proved; for thus only can any rational account be given of various phenomena familiar to the physiological botanist and the practical gardener, but which are not the less curious because they are common. Certain exotic plants remain free from blights, *i. e.* from the attacks of insects and parasitic fungi; while native vegetables, in the same field or garden, are profusely covered by them, and oftentimes consumed: in such a case the plants have been brought here, but their parasites have been left behind. Again, many exotic plants are not exempted, because either their parasites have been imported with them, or they have found in a foreign land others that, if not identical with those of their native climes, are equivalent in their functions, and which in different places perform reciprocally the duties of each other, as they are severally absent.

(733.) But, so little have the fungi hitherto been studied in tropical regions, or indeed in any countries out of Europe, that, of the extra-European species, there is absolutely next to nothing known. I am therefore most happy to learn, from my friend, Dr. Harlan, of Philadelphia, that Drs. Schweiniz and Torrey, both well-known and very able botanists, are prosecuting their researches amongst

the American fungi; and doubtless a rich harvest will be gathered in the vast wilds of that magnificent country, on which England, nay Europe, looks as the coheiress of her language, literature, sciences, and arts.

(734.) The chief geographical generalizations with regard to the fungi which can as yet be made are very few; they are not, however, wholly unimportant.

(735.) Fungi chiefly affect northern latitudes, and the northern parts of the temperate zone. They are much more numerous in Sweden than in France; more common in France than in Italy and Spain; and still less abundant in Barbary, and the northern parts of Africa, than in Europe. Within the compass of a square furlong in Sweden, Fries states that he found no less than two thousand species; and, although not equally multitudinous in all extra-tropical countries, they are much more numerous in the temperate than in the torrid zone. To this a parallel may be traced in the seasons which here are most favourable to their growth; for, in England, fungi are comparatively rare in summer, but occur in our forests and our fields, and in almost every possible locality, in the extreme of profusion during autumn, and even in the beginning of the winter months.

(736.) The *Sphærinæ*, and some of the *Mucedinales*, which cover the leaves and bark of many trees during the summer here, and which abound on decaying food in every season, may seem to offer serious objections to the above general law. On the contrary, however, they confirm it; for the *Sphærinæ* are those lichenöid fungi which were excluded by De Candolle from the class, and associated with some few lichens to form his intermediate group Hypoxyla; and which, as they are abundant during our summer, are common also in every part of the world where there are vegetables for them to grow upon.

(737.) Like other plants of which more is known, the geographical range of the several orders, sections, types, and genera of fungi, appear to be very different, and yet to be subject to general laws; for some, as the *Sphærinæ*, *Agaricinæ*, and *Tremellinæ*, are almost cosmopolites; while others, as the *Tuberaceæ*, the *Helvellaceæ*, and the *Clavariaceæ*, although not wholly, are chiefly European plants. This difference of range, which is evident in some of the types and sections, is also noticeable in many genera and species: thus the common mushroom, *Agaricus campestris*, is spread over the whole of Europe, and part of Asia, Africa, and America, reaching as far north as Lapland, and as far south as Barbary and Japan. The *Schizophylla*, also, which are found throughout the whole of

Europe and Asia, occur likewise on the Gold Coast and at the Cape of Good Hope, as well as in the Antilles, and in North and South America; and the truffle, which is so especially European, is also a native of the East Indies and Japan. On the contrary, *Batarrea*, one of the Phallaceæ, has only been found in England, and is very rare even in its special habitat; and *Onygena*, a curious fungus, has never yet been discovered anywhere but on horses' hoofs, lying to rot in shady places.

(738.) Equinoctial countries are not, however, destitute even of the larger fungi, and some of the tropical species are remarkable both for their form and size. "The huge Boleti of Java," we are told, "spread out their many-handed bodies from the trunks of aged trees, like vegetating demons;" and some of the terrestrial fungi of warm countries are so large, that travellers report they have been mistaken for sleeping lions. Nevertheless, although not absent, fungi are much less common near the equator than in higher latitudes; for in some intertropical places they are extremely rare, and in others perhaps unknown.

(739.) No fungus has hitherto been found in a fossil state. Nodules of iron pyrites, which assume almost every possible diversity of form, have sometimes been mistaken for fossil fungi; and indeed, their occasional resemblance to certain species, as the Agaricus pratensis, is very close, [vide § 600, fig. H, I.] But the multitudinous shapes the nodules assume, the situations, and abundance in which they are found, and, above all, their chemical constitution and the absence of any traces of organization, preclude the idea of their being the remains or casts of fungi. In Lindley and Hutton's valuable work, a fossil is figured under the name of *Polyporites* [Pl. 65], which, if indeed a fossil fungus, would be most valuable, as being the first ever yet discovered. But Mr. Bowman, who found it among the ejected shale of a coal-pit, near the entrance of the vale of Llangollen, in the county of Denbigh, and who subsequently met with a second and more perfect specimen, points out their resemblance to the scales of fish, or of some great Saurian reptiles. Hence, notwithstanding their similitude in a few respects to the recent genus *Polyporous*, much doubt is reasonably entertained of their vegetable origin: and further evidence must be adduced, before they can be acknowledged as fossil fungi.

(740.) The absence of fungi from the more modern strata may be satisfactorily explained, by the consideration of the very fugacious nature of most, and the more or less perishable structure of the remainder. Few are known which would be likely to retain their forms, when carried into lakes and seas, long enough to be sealed up by successive deposits in the heart of nascent stone. In the older series, fungi could not be expected to be found; for, as they are aerial plants, those strata in which aquatic Algæ alone have been discovered, would be very unlikely situations for fungi; and as fungi are chiefly parasitic on trees, shrubs, and herbs, it would be folly to seek for them in the deposits of epochs in which terrestrial vegetables did not exist: furthermore, as fungi now are known to affect the colder regions of our globe, and to be comparatively rare in our warmer latitudes, the older the strata in which fossil plants are found, as they indicate a temperature higher than the present, the less and less likely will they be to contain any fossil fungi.

OUTLINES OF MUSCOLOGIA.

(741.) Moss, Mousse, Muscus, and other synonymes in other tongues, had once a far more extensive meaning than they now possess; for not only were the mosses properly so called included in their ample sweep, but all kinds of soft and capillary plants, whether growing in the sea, in rivers, in swamps, or on dry land, were considered mosses, and even the places in which they grew received similar denominations: hence, to the present day, large tracts of boggy country, both in the British Isles and in the northern parts of Europe, are commonly known as Mosses.

(742.) Most of the ancient sea and river mosses have already been proved to be Confervæ; many of the terrestrial ones, as the rein-deer and Iceland mosses, have been shewn to be Lichens; the parasitic mosses, forming mouldiness or mildew, have been demonstrated to be Fungi; and the club-mosses will hereafter be found, in like manner, to be associated with the Ferns. Thus restricted on every side, the ancient indeterminate and undefinable group once called mosses has been reduced to a definite and natural modern class: which, although relatively diminished in extent, has been hindered, by recent discoveries, from becoming absolutely lessened in the number of known plants that it includes.

(743.) As was the case with both the Algæ and the Fungi, some systematic writers would confine the *Musci* within much narrower limits than it is here proposed to draw. That is, as they would consider the *Fucales* the only *true Algæ*, and the *Boletales* the only *true Fungi*, so, among the mosses, one order alone has been termed true mosses (*musci veri*), and the others altogether excluded, and deprived of the common name.

But, as in the previous instances, of the Algæ and the Fungi, so likewise here, among the Musci, the several subordinate groups can

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be equally well distinguished when considered orders of one common class, as when no such association is acknowledged; and furthermore, as such a distribution not only shews their natural affinities, but is also sanctioned both by popular acceptation and by many of the highest botanical authorities, they will be here admitted as the individual orders which form, collectively, a common class. Respectively, they are called *Hepaticales* (or liver-worts); *Bryales* (true-mosses, or moor-worts); and *Charales* (or stone-worts.)

(744.) Characteristically different as the mosses are from both the Algæ and the Fungi, and no class possesses more decided diagnostic signs, they still exhibit, especially in the two boundary orders (the liver-worts and the stone-worts), several very strong connexions with some of the foregoing groups, and more particularly with the *Confervales* and *Lichenales* of the *Algæ*. Indeed, the *Charas* are even now, by Agardh, Esenbeck, and Ebermaier, placed among the *Confervaceæ;* although they little accord with their general definition of the *Algæ*, and a much more important affinity has been pointed out with the Equisetaceæ of the following class. Again, the Liverworts were by many of the older writers once thought to be so intimately allied to the Lichens, that some of them were called, by Fabius, Dillenius, &c., *Lichen alter*, *Lichenöides*, and *Lichenastrum*, while Linnæus collectively named the whole *Algæ Hepaticæ*, a term which modern writers have changed for *Musci Hepatici*, the Liverworts, or Hepatic mosses.

HEPATICALES.

(745.) The known Liverworts are comparatively few in number; the entire catalogue of British and foreign species does not amount to 240. These are distributed into thirteen genera, one of which, viz. *Jungermannia*, contains 199 of the species; so that there are but thirty-eight left for the remaining twelve. Out of these *Marchantia* takes ten, *Lejeunia* and *Riccia* each seven, *Fimbriaria* five, *Anthoceros* two; and, consequently, seven genera, viz. *Lunularia*, *Grimaldia*, *Targiona*, *Corsinia*, *Monoclea*, *Blandovia*, and *Sphærocarpus*, each include but a single species.

(746.) So small an order needs but little subdivision; and, were it not for some peculiarities of structure, the genera might all be kept without any analytic hindrance in a single type, as they are in a single section.

HEPATICINÆ.

(747.) The stages of evolution by which a passage is effected from the Lichens to the true mosses may be regarded as characterizing three natural groups, and these, from their normal genera, *Riccia*, *Targiona*, and *Marchantia*, may be called the *Ricciaceæ*, *Targionaceæ*, and *Marchantiaceæ*.

(748.) RICCIACEÆ. Differing widely as all the mosses do from the Lichens in their organs of vegetation, their herbaceous fronds exhibiting a rich lucid green in place of the dry coriaceous thallus of *Cetraria*, the wild dishevelled locks of *Usnea*, or the powdery crusts of Opegrapha and Graphis, still there are found, as already stated, some curiously interesting species in the genus RICCIA, which more particularly mark the transition from the foliaceous Lichens to the Liverworts. As far as observation hitherto has gone, the fructification of the Ricciæ is imbedded in the fronds, and this character it is which shews the affinity of these plants with Endocarpon of the Lichens, and establishes them as the connecting links between the Algæ and the Musci; while it beautifully traces the transition of the preceding into the present class.

As was the case with Lepraria among the Lichens, as well as with several other instances already mentioned, no fructification has been yet discovered in some species of Riccia, but in others it is peculiar and distinct.

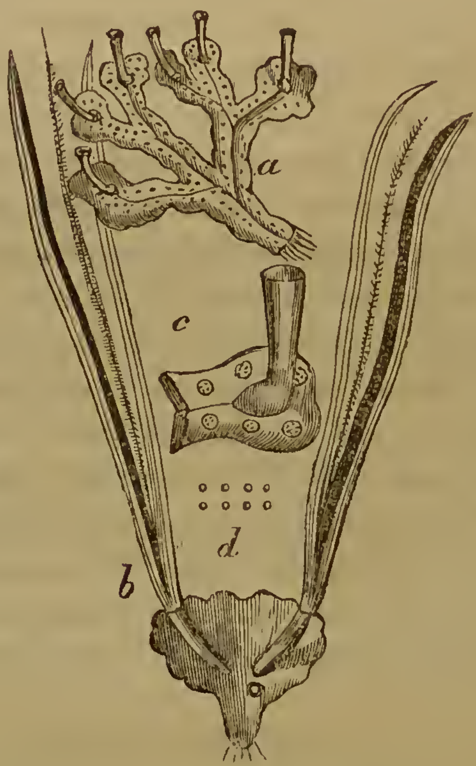
(749.) In *Riccia glauca*, for example, numerous small points are found scattered over, and projecting from, the surface of the leaf-like fronds. These are called *Setulæ*, (sometimes styles, the reason for not adopting which term will be evident hereafter, when the nature of the true style has been explained). Below the setules, immersed in the substance of the frond, are seated cases called *urns* or *thecæ*, in which the sporules are contained. These *urns* are indehiscent, or open only by decay and rupture.

(750.) The indehiscent immersed thecæ distinguish the Ricciaceæ from the other types; they are also, of course, the generic characters of the solitary genus Riccia.

(751.) The Ricciæ, which have been named in memory of Ricci, a Florentine botanist, are for the most part fresh-water plants; some, as *glauca* and *spuria*, grow on shaded rocks, in bogs among mountains, or in other damp places. No use has hitherto been made of them, and their properties are unknown.

(752.) TARGIONACEÆ. The *Thecæ*, or *Urns*, which in the

Ricciaceæ are immersed in the frond, become, in the several genera of the succeeding type, more or less exserted; the stalk, on which the theca thus is raised, has been called the *pedicule*, *urn-stalk*, or *theca-pode*. The urns are dehiscent by valves [fig. *b*], in the four genera contained in this section, called the *Targionaceæ*. In *Monoclea* (a foreign genus), the urn consists of only one piece or valve (theca, or urna univalvata.) In *Anthoceros* (the flower-



(*a*) *Jungermannia pusilla*, or *Blasia pusilla*.

(*c*) Ditto, portion in fruit magnified.

(*d*) Sporules.

(*b*) *Anthoceros punctatus*, shewing the two valved urns and the columella, to which the sporules are attached.

horn), it divides into two (urna bivalvis), as likewise in *Targiona*. Covering the urn in its early stages, and often surrounding its base when more fully developed, there is found a cup-shaped elevation of the frond called a calyx (or rather a calycel), of which there is no trace in the *Ricciaceæ*. In two of the genera, viz. *Targiona* and *Monoclea*, the *sporules* are accompanied with numerous spiral threads called *Elateres*, shewing thus the greater affinity of these with the Marchantiaceæ [§ 753, fig. *n*,] than can be claimed for Anthoceros and Sphærocarpus, in which no Elateres are found. The genera with Elateres form the *Targionidæ*, while those destitute of these spiral threads constitute the subtype *Anthoceridæ*.

Their veil-less urns associate these genera, and distinguish this from the following type.

(753.) Marchantiaceæ. Two genera named after *Jungermann* and *Marchant*, the latter of whom was the first foreign botanist

that the French Academy of Sciences admitted amongst its members, are distinguished from the preceding section by the presence of two coverings to their urns or thecæ, the outer one, or calycel, analogous to the calycel of the *Targionaceæ*, the inner a new organ named by botanists *calyptra*, or *veil:* the calycel is some-

Marchantia polymorpha.

(*a*) The *peltapode* springing from (*b*) the frond, and bearing the *pelta* or *shield;* which is the common receptacle of many urns. (*j*) A pelta or shield reversed. (*k*) A *theca* supported on its *thecapode*, and surrounded by its *calycel*, or *perichætium*, having burst through its *calyptra*. The Elateres and sporules are shewn by the dehiscence of the urn, the edge of which is notched into about eight teeth. (*l*) Portion of the frond elevated, and forming a receptacle or origoma, in which are contained small bodies, believed to be equivalent to buds or bulbils. (*m*) A shield bearing *urnulæ* or *pseudo-thecæ*. (*n*) *Elateres* with sporules. (*c*) A sporule swelling previous to germination. (*d*, *e*, *f*) *Sporules* in different stages of development. (*g*) An instance of irregular growth. (*h*) Regular growth, showing the maternal vesicle, and those subsequently formed. (*i*) The foliaceous frond produced by the further development of cellules, at first similar to the sporules, but subsequently changing their spherical forms for multangular figures.—(*Mirbel's Monograph*).

times obscure or absent, the calyptra never abortive. Marchantia is frondose in all its species, although the fronds are deeply divided, giving them a more or less foliaceous appearance [fig. *b*.] From the frond arises the common receptacle of several urns [fig. *a*]: the expanded summit of this common receptacle is called the pelta or shield [fig. *j*], and the elongated base or stalk [fig. *a*], the *peltapod*. The urns or thecæ are covered by two membranes,

the calycel [fig. *k*] and calyptra, and contain numerous sporules mingled with elateres [fig. *n*.] Besides the regular urns, there are other organs found on peltate receptacles, which have not always peltapods, and are supposed to shew some analogy to parts hereafter to be described under the name of *Anthers* [fig. *m*.] But their use is not well known, and hence their better name would be urnulæ or pseudo-thecæ. Sometimes the urnulæ are found as in *M. androgyna*, a variety of *M. hemisphærica*, on the upper surface of one half of a shield, the lower surface of the other half of which bears the urns or thecæ. The fronds are also studded with knots, or *gongyles* [fig. *l*], which germinate even while attached to the parent plants. These vegetables are therefore viviparous as well as oviparous. The buds are surrounded by variously-shaped foliaceous projections, called by some persons origomæ or origomes.

(754.) Jungermannia, the other genus, has no common receptacle collecting its thecæ together, but each urn is raised upon its own seta, Chætium or Thecapode, and dehisces or opens by four valves [§ 59, fig. A]. The perichætium is sometimes, but rarely, abortive in the Jungermanniæ, the calyptra is always present. One subdivision of this genus contains frondose plants, resembling the Marchantiæ, while another developes the foliaceous projections in the manner of leaves marking the transition of this type, the *Marchantiaceæ*, to the next that follows, viz. the *Andræaceæ* of the commonly called true mosses.

(755.) The foliaceous productions that surround the thecapode are called the *perigonial leaves*, or perhaps better, the *perichætium* or perichætial leaves, as investing or being set round the *seta*, or *chætium*. In the axillæ of these perichætes there are generally found minute spherical bodies of a membraneous reticulated texture, which, like the false urns or pseudo-thecæ of Marchantia, have been called anthers. It is however better, as nothing is really known of their use, to call them, as in the previous instance, not *anthers*, but *urnulæ* or *pseudo-thecæ*.

(756.) The Jungermanniæ are small obscure plants, growing in damp situations, creeping over the trunks of trees, the surface of rocks, or the moist earth, and which seldom attract much notice. The monograph of Hooker upon the British Jungermanniæ has, however, elevated them from their obscurity, and shewn these neglected plants to be among the most exquisite examples of Nature's works.

None of them are poisonous, or in the slightest degree hurtful; their taste is mild: some few, as the *J. pusilla*, are fragrant, but not possessed of any very sensible properties. Not one of the species has hitherto been applied by man to any useful purpose.

(757.) The study of these plants has therefore sometimes forcibly struck me as being a more decided proof of a disinterested love of science, than the investigation of other richer and more directly rewarding tribes. The Jungermanniæ afford neither clothing nor fuel, they yield neither food for the hungry nor medicine for the sick. Hence they have been contemned as useless, and their study proscribed as a useless occupation. But is it so? Are they altogether worthless? Are there not functions performed by these, and many other plants, *as worthless*, which are of vast importance in the general economy of nature? functions which indirectly, if not directly, minister to the comforts and conveniences of man. The uses which nature makes of plants are often more beneficial to us than any uses we can make of them ourselves: and should aught created be despised as useless, by those whose ignorance alone it is that, in all likelihood, prevents them discovering its utility?

But there is a use in studying the works of the Creator far beyond the discovery of the uses to which these, his creatures, may be applied; far beyond the discovery even of the blessings he has provided for our enjoyment: for when they afford neither sustenance nor physic for the body, they yield both food and medicine for the mind. "Do not, therefore, depreciate any pursuit which leads man to contemplate the works of God." To the merchant, the courtier, or the bookworm, the journal of a naturalist may appear to contain memoranda of little importance. But to such, if they scorn his labours, he may answer in the words of Southey, that he has "in his pursuit, as they in theirs, an object that occupies his time, and fills his mind, and satisfies his heart. It is at least as innocent as theirs, and as disinterested—perhaps more so, because it is not so ambitious." Nor can the pleasure he feels in the discovery of a plant, or in the investigation of its wonderful structure, be less pure or less worthy, than what they derive from the perusal of the noblest productions of human genius: nay, is it not likely to be both more pure and more worthy?

(758. The Marchantias seem to have been formerly regarded as the more especial Liverworts; they being called *Hepaticæ* and

Jecorariæ, while the frondose Jungermanniæ were termed *Hepaticöides*. The signature physicians attributed wonderful curative powers to these plants; especially to the Marchantia polymorpha; the lobulated fronds of which species, from a fancied resemblance to the liver, caused it to be esteemed a specific in jaundice, and other hepatic complaints. Since signature medicine has been exploded, the liverwort has fallen in this country into unmerited neglect; but it is still retained as an officinal plant in Germany. It has a very penetrating, though mild pungency, and bitter taste. It is both cathartic and diuretic, and appears to possess no inconsiderable virtues.

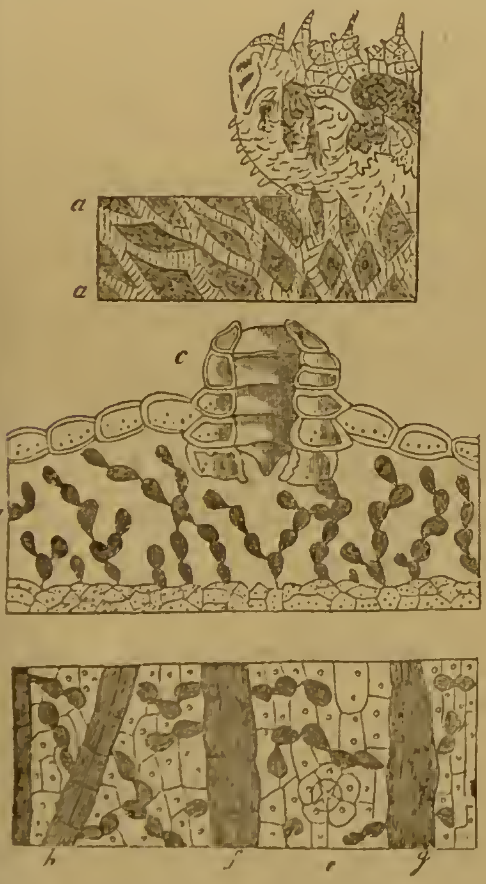
(759.) Although discarded by the learned from their lists of remedies, the liverworts have never been entirely lost sight of as domestic medicines. In our provinces, and in Ireland, as well as in Germany, they have always maintained their reputation.

Induced by this popular belief, and persuaded by the representations made to him by one who had personally witnessed its good effects in dropsy, Dr. Thomas Short determined to give the *Marchantia hemispherica*, another species of liverwort, a trial in some of those cases which he had failed to relieve by the usual means, and in which it was said to afford often the most decided benefit. After an extensive trial for several years, the report which he has published is most satisfactory. He did not find it so efficacious when internally administered as others are said to have done, but externally applied in the form of poultice, he says, he found it "astonishingly successful;" and therefore, although, like other diuretics, it has sometimes failed to cure, he considers it on the whole as of great value as a remedial means.

He directs the poultice to be made by carefully picking and washing about two large handfuls of the liverwort, which are to be put into a quart of boiling water, and simmered for twelve hours, adding more water as it may be required. The leaves are then to be beaten into a pulp, and as much linseed-meal stirred in as will bring the mass to a proper consistence. The poultices, spread on flannel, may be applied either to the abdomen or the legs, or to both as occasion may require, and should be renewed every twelve hours until the water has been drained off, or the application proved to be ineffective, which will become evident in the course of two or three days. The ordinary effects of these cataplasms are, first, to produce copious perspirations, and secondly, to act powerfully on

the kidnies. Tight bandages should be wound round the body in cases of abdominal dropsy; otherwise a feeling of exhaustion, as is common after tapping, may come on. Dr. Short says, he was not accustomed to exhibit any medicines internally, while the poultices were being used, unless the sense of sinking just mentioned became distressing; when, although he never knew any harm to follow, he gave small doses of the nitrous spirit of ether. The effects of the liverwort, he says, were much increased by the free exhibition of warm diluents, and those which are slightly nutritious, seemed to be the most beneficial. In conclusion, he adds, that the plan of treatment he describes appeared to be most successful in cases in which other remedies had been extensively employed and failed.

(760.) *Marchantia polymorpha*, has lately been rendered peculiarly interesting in a physiological point of view, by Mirbel having shewn, in a memoir just published, that certain organs called *Stomata* exist in this plant, which were previously denied to be present in any of the mosses or their allies, indeed in any vege-



(*a*, *a*) Portion of the frond *Marchantia polymorpha*, with a section of one of the cup-shaped receptacles containing buds, called by some persons an *origoma*. The surface is divided by green lines into lozenge-shaped compartments, in each of which is a large stoma.

(*b*) Transverse section of the frond, shewing the upper and lower cellular layers.

(*d*) Ditto, intermediate cellular structure, the cells in lines with intervening passages.

(*c*) Section of a stoma across its smallest diameter, to shew the cellular structure of which it is formed, and the opening into the air-chamber.

(*e*) Air-cells and stomata.

(*f*, *g*, *h*) Bands of cellular structure which bound the air-chambers.

tables lower in the scale of creation, than the ferns. He has, however, proved that they not only do exist, but that they exist in perfection; and, in tracing their evolution, he has thrown much very

important light upon an obscure branch of vegetable structure. Mr. Griffith has likewise found Stomata in *Targiona hypophylla.*

(761.) The three groups now enumerated and described, are associated in the common order *Hepaticales*, an order which is readily distinguished from the succeeding, by the urns in all the genera being destitute of an organ call *an operculum*, or lid [§777, fig. *c*, *i*], which is universally present in the *Bryales*. Hence the liverworts have sometimes been called *Musci de-operculati*, while those genera, included in the next order which all have lids, have been named the *Operculate* mosses. With the stoneworts which are submerged leafless plants; having indehiscent axillary fruits, they can never be confounded, [§ 786.]

(762.) Although confessedly alike each other in habit and in their organs of vegetation, the organs of fructification in the liverworts, as will have been already observed, are so different, that a question arises as to whether the three groups, in which they are arranged, should not be considered three *sections* of the order Hepaticales, rather than three types of the same section. Riccia, whose immersed urn dehisces only by rupture, contrasts most strongly with the other groups, in both of which the urns are discrete and mostly dehisce by valves. And although the valvular dehiscence is common to both these, in Targiona and its allies, the urns are veil-less: while in Marchantia and its allies, they are veiled; all characters sufficiently strong to distinguish sectional groups. Moreover the two genera, *Jungermannia* and *Marchantia*, which are contained in the first, differ so widely by the former having the urns solitary, and in the latter collected upon a common peltate receptacle, that they might justly claim to be considered the normal genera of separate types. The urns of *Targiona*, *Lunularia*, *Lejeunia*, *Fimbriaria*, and *Monoclea*, containing elateres amongst the sporules, while in *Anthoceros*, *Corsina*, and *Sphærocarpus* there are none, have already been mentioned as characters by which this might be divided into two subordinate groups. And as to *Riccia*, it is a genus in its type alone.

But as this is a question as to the extent to which analysis should be carried, and the degree of similitude that should be required in plants synthetically associated in the more or less comprehensive groups, which come between the genera and classes, it is one in which speculation too freely mingles to afford a reasonable hope that it will ever be settled to the satisfaction of all.

BRYALES.

(763.) This order includes those mosses to which, alone, some persons would confine the name, and the study of which, alone, would thus form the extent of their muscology. But as the words *Lichenologia*, *Phycologia*, &c. are occasionally used to designate the especial studies of the *Lichenales* and *Fucales*, of the *Algæ*, so *Bryologia*, an equivalent term, is one as common and far more appropriate for this subdivision of Muscologia, whenever it requires a distinct denomination. For these *Foliose* or *Operculate* mosses, the Brya (Βρυα) of the Greeks and Romans, form the Bryales of the present scheme; and the *Bryaceæ*, *Bryöideæ*, &c. of Bartling, Reichenbach, and other authors. That they have no prescriptive right to the exclusive possession of the title, "True Mosses," (Musci veri,) has been already shewn: and why they should ever, for the sake of distinction from the Hepaticæ, have been called *frondose mosses*, it is difficult to conceive, as not a single example can be cited which has a *frond*, while the majority of the liverworts really are *frondose*.

(764.) The Bryales, or *foliose-mosses*, are easily distinguished from the *liverworts*, by the possession of an *operculum* (or lid), which covers the *urn* (or theca), in which are contained the seeds (or sporules.) They are much more numerous than either of the allied orders, and are therefore distributed into three sections, which are distinguished by the varied dehiscence of the urns. From the normal genera, *Andræa*, *Bryum*, and *Phascum*, these three sections are called the Andræasinæ, Bryacinæ, and Phascinæ.

(765.) Before describing the variations in form which characterize the several types and sections of this order, it will be advantageous to give a slight sketch of the general structure of the whole, because a considerable advance is here made in the evolution of organs, some of which are perfected which were only commenced in the liverworts; and hence many new terms are required in their description.

(766.) The lower part of the general axis in mosses is prolonged into a fibrous root, entirely composed of cellular structure [§ 59, B.] The ascending axis is called a *surculus*, not frond, as in the liverworts, because the thecæ spring from the axis, not from its foliaceous expansions; an effort towards which is seen in the higher Jungermanniæ [§ 50, A.] The regular divisions [§ 768, *a*] of the general axis are called *branches*, those which are irregular *innovations;* and the foliaceous appendages, of which no moss is entirely destitute, *leaves*. Beneath, and among the leaves, are

small foliaceous productions called Stipules. The fructification is of two kinds [§ 59, B], as in the liverworts: the small spherical bodies lodged in the axillæ of the leaves have been called *Anthers*, to which name, however, there is a serious objection, and it may be better, as before, to call them urnules or false urns. The *thecæ*, or true urns, are either sessile, or supported on a bristle [§ 59, B], which is named the *seta* (or chætium), and the leaves which surround the seta (or chætium) the *perichætium*. The urn or theca is closed by a lid, named *operculum* [§ 774, *b*; 777, *i*], and covered by a veil, *Calyptra*. The Calyptra opens in different ways; it is either irregularly torn, as in *Andræa* [§ 768, *e*], entire at the base, or only shewing some short clefts, as in *Splachnum*, when it is called *Mitral* [§ 780, *e*]; or if one long cleft extends upon one side only as in Tortula, Polytrichum, Hypnum, and many others [§ 778, *i*; 774, *a*, &c.], then it is termed *dimidiate*. The vaginule is the base of the calyptra, which remains within the perichætium at the base of the urn after the upper portion has been torn away and elevated by the growing theca [§ 781, *c*.]

(767.) The opening of the theca to discharge the spores that it contains is called its *dehiscence*. In one section it dehisces longitudinally by valves [§ 768, *c*, *d*], in another, transversely at the junction of the operculum [§ 777, *i*], and, in the third, [§ 769, *d*,] it is indehiscent; the sporules only escaping on the solution, rupture, or decay of the thecæ.

When the operculum or lid is removed, the opening into the urn is seen, which is called its mouth or *stoma*, [§ 780, *d*,] which is sometimes naked, [§ 781, *c*, *f*,] at other times set round with a fringe, called *peristome*, which is either double or single [§ 777, *d*, *e*, *f*, *g*, &c.]; and, according as the processes are membranous, hair-like, or tooth-like, they have received their respective denominations. The peristome is occasionally embraced by an elastic ring (*annulus*), and sometimes has internally some delicate filamentary projections, named *ciliæ*. The sporules are attached to a prolongation of the floral axis within the urn, which is called the *columella* [§ 780, *d*], and the *sporules* are unaccompanied with *Elateres*. The urn is often enlarged on one side of the base, which swelling is called a *struma*, and, if prolonged downwards, the projection is named an *Apophysis*. The fine membrane, which is occasionally found stretched across the peristome, and closing the (stoma) mouth of the urn, as in the many-hair moss (Polytrichum), is called the *Epiphragm*.

But these numerous and very curious organs are not all present in all mosses, and, in consonance with the general scheme thus far pursued, their successive evolutions shall be illustrated by examples.

ANDRÆASINÆ.

(768.) Andræaceæ. *Andræa*, a moss that commemorates either André, a German botanist, or Andreas de Castro, physician to one of the Dukes of Braganza; or Andreas, a celebrated naturalist of antiquity, who has been honourably mentioned by Pliny,

Andræa.

(*a*) Two plants of A. nivalis, natural size.

(*b*) Cauline leaf, magnified.

(*d*) Urn and perichætial leaf, magnified.

(*f*) Unopened urn of Andræa alpina.

(*e*) Torn calyptra.

(*c*) Open urn, shewing the valvular dehiscence, and conjunctorium, or adherent operculum.

(*Hooker and Taylor.*)

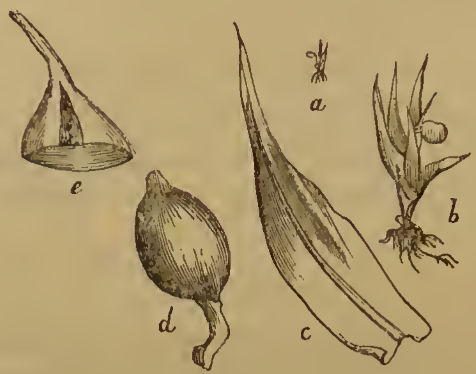
marks the transition of the true mosses from the liverworts, by shewing their connexion through it, with the Jungermanniæ and some of the Targionaceæ. For, although the stem of *Andrea*, its operculated theca, and its destitution of Elateres, distinguish it decidedly from the Hepaticales, and locate it among the Bryales; still its dehiscent urn, splitting into four valves, like Jungermannia, points it out as the osculant genus.

Thus is the gradation carried on from the foliose Jungermanniæ, by the urn of Andræa, the only genus in the type *Andræaceæ*, and section *Andræasinæ*, retaining the Hepaticine character of dehiscing longitudinally by valves; and, although possessed of an operculum or lid, the essential organ of all the Bryales, still having this lid persistent; *i. e.* not opening as a lid to allow the escape of the sporules, but connecting the apices of the valves together; and hence it is sometimes called the *conjunctorium* [fig. *c*, *d*.]

There are several species of Andræa, two, which were formerly classed as liverworts, being named by Linnæus, *Jungermannia alpina* and *J. rupestris*, and even now by some they are denominated *musci desciscentes.*

PHASCINÆ.

(769.) PHASCACEÆ. *Phascum* is the only other known British moss which retains its operculum like *Andræa*, from which genus,



Phascum curvicollum.

(*a*) Plant, natural size.
(*b*) Ditto, magnified.
(*c*) A leaf, still more enlarged.
(*d*) Indehiscent urn of P. cuspidatum.
(*e*) Dimidiate calyptra of ditto.
(*Hooker and Taylor.*)

however, it widely differs, by having indehiscent thecæ. *Voitia* and *Bruchia* are two foreign genera, which, possessing the same peculiarity of structure, are associated with it in the type *Phascaceæ*, the only one included in the section *Phascinæ*.

(770.) The generic name *Phascum* is but slightly altered from the original Greek φάσκον, the meaning of which is not, however, very obvious. The *Phasca* are amongst the most diminutive of the mosses, some of them being scarcely discernible, and others all but invisible to the naked eye. Notwithstanding their minuteness they are very dissimilar in their forms; and many so extremely curious and beautiful, that the speculative would derive φάσκον from φαω, to shine.

BRYACINÆ.

(771.) *Bryum* and *Sphagnum*, with thirty other associated genera, form the section *Bryacinæ*. This section, which is the largest in the order, and indeed much the largest in the class, includes nearly nine hundred and fifty out of the nine hundred and seventy-one species enumerated in Sprengel's catalogue. They are all, however, notwithstanding their number, easily recognized by their deciduous opercula; a character by which they are therefore readily brought together, and known from the *Phascinæ* and *Andræasinæ*.

(772.) But the *Bryacines*, although collectively known by their deciduous opercula, have very differently developed urns.

Sphagnum, and its allies, which constitute the type SPHAGNACEÆ, are like the *Phascaceæ* and *Andræaceæ*, destitute of Peristome.

Splachnum, and its allies, have a peristome, but it is single and

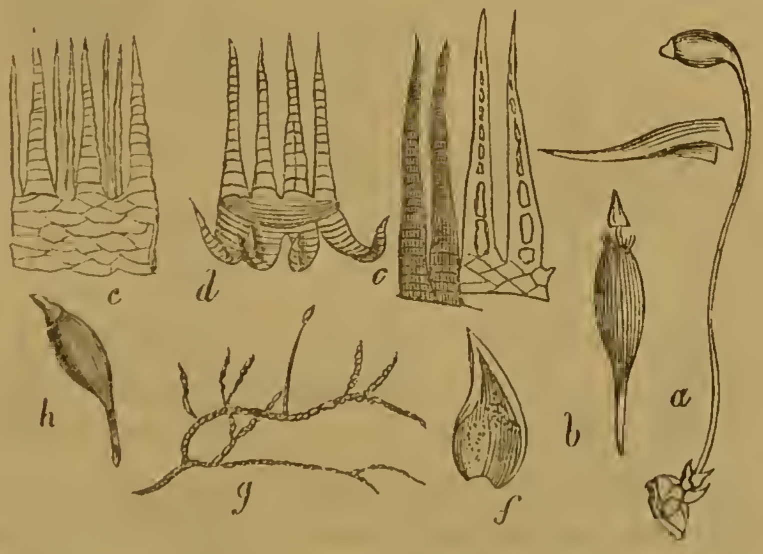
consists of one whorl only of metamorphosed leaves, which character distinguishes the SPLACHNACEÆ.

While *Bryum*, *Hypnum*, and their immediate allies, which form the type BRYACEÆ, have a double peristome; the inner being sometimes membranaceous, sometimes formed by *ciliary processes*, and sometimes of teeth similar to the outer peristome.

(773.) BRYACEÆ. *Hypnum* (the feather-moss), and *Bryum* (the thread-moss), two of the largest genera in this order, and, excepting *Jungermannia*, the most extensive in the class, although associated by their double peristomes, differ in a character which by some Bryologists is deemed of primary importance; that is, in *Bryum* the thecæ or urns are terminal, [§ 777, fig. *a*; 778, *a*, *d*,] while in Hypnum they are lateral, [774, *g*.] Desiring as far as possible to derive the associating characters from the fructification, by which the most natural groups are formed, the relative position of the thecæ is here only esteemed a subordinate diagnostic sign, distributing the *Bryaceæ* into two subtypes. *Hypnum*, with Hookeria, Daltonia, Neckera, Fontinalis, and others, in which the urns are lateral, are thus associated to form the subtype *Hypnidæ*; while *Bryum*, with Polytrichum, Funaria, Orthotrichum, and Buxbaumia, in which they are terminal, constitute the subtype *Bryidæ*.

(774.) *Hypnidæ*. Of the hundred and twenty-nine species of Hypnum, there are very few that minister directly to the wants of man. *H. triquetrum*, from its extreme elasticity and lightness, is much used for packing brittle wares. *H. purum* is used by anglers

Hypnum.



(*a*) H. rutabulum with urn, operculum, and calyptra. (*b*) Urn and operculum of H. dendröides. (*c*) Portion of peristome of ditto. (*d*) Inner peristome of H. complanatum. (*e*) Ditto of H. rutabulum.

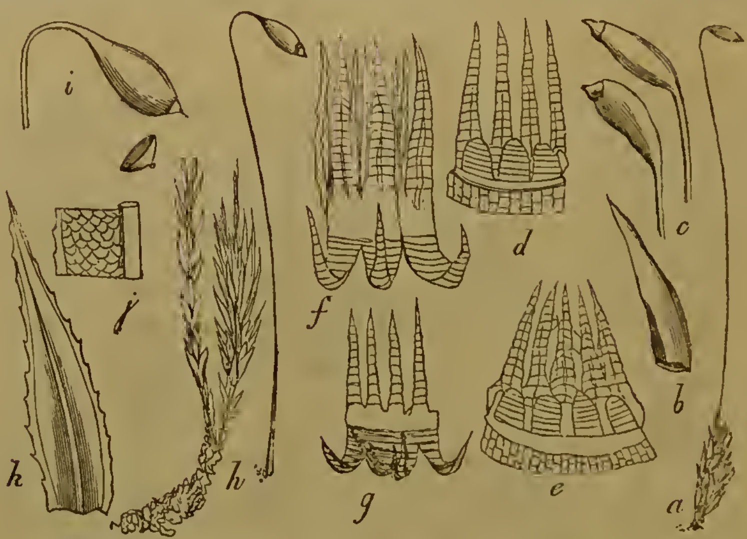
for the purpose of scouring worms, whence its specific name; true Waltonians prefer this species; half-bred anglers use it indiscriminately with other mosses. *H. proliferum* is greatly employed for insuring the safe transport of leeches; they travel with far less injury when protected by the moss, than when in vessels of water only.

(775.) Johnston states, in his very interesting Flora, that the petrified moss so abundant in the neighbourhood of Berwick-upon-Tweed, is the *H. commutatum*: tufts of which are encrusted and solidified by a deposition of the lime thrown down from the water in which it grows. It delights to hang over the precipitous fronts of dripping rocks, or of small cascades whose waters strain themselves through the dense and plumy foliage as through a sponge. Leyden must have had it in view when he wrote the "Listless Shepherd."

> "His is the lulling music of the rills,
> Where drop by drop the scanty current spills
> Its waters o'er the shelves that wind across,
> Or filters through the yellow hairy moss."

(776.) The *Fontinalis antipyretica*, is employed in Sweden to fill up the spaces between the chimney and walls, and thus by excluding the air, it prevents the action of the fire upon them. Hence it derived its specific name *antipyretica*, which has led to the erroneous idea that it is absolutely incombustible.

(777.) *Bryidæ*. The *Brya* are plants of exquisite beauty, often



(*a*) Bryum cæspiticum, natural size. (*b*) Calyptra of Bryum triquetrum. (*c*) Urns, with opercula of B. triquetrum and B. palustre. (*d*) Peristome of B. ventricosum. (*e*) Ditto of B. elongatum. (*f*, *g*) Portions of the peristomes laid open. (*h*) Bryum hornum, natural size. (*i*) Theca, and operculum. (*j*) Portion of leaf, shewing cellular structure. (*k*) Whole leaf, magnified. (*Hooker and Taylor.*)

resembling in miniature the forms of some of our noblest palms and forest-trees. The *Funariæ* are very common, especially the F. hygrometrica, which is met with almost everywhere. It, however, chiefly luxuriates in those soils which have been charred, or where wood has been burned. The fruit-stalk is possessed of remarkable hygrometric properties, and indicates very slight variations of atmospheric moisture. From its thus becoming twisted like a cord (funis), its name Funaria has been derived.

(778.) Polytrichum is another large genus contained in this subtype. Johnston, to whose work I am indebted for much economical information of importance, says, in the north of England mattresses superior to those of straw are sometimes made with the Polytrichum commune, and we have seen door-mats, and very neat brushes, made of the luxuriant stems collected from bogs. "When well combed and dressed, (says Mr. White, in his Natural History of Selborne,) and divested of its outer skin, it becomes of a beautiful bright chestnut colour, and being soft and pliant, is

Polytrichum.

(*a*) Plant of P. piliferum, shewing the theca, and operculum.
(*b*) Point of leaf.
(*c*) Whole leaf magnified.
(*d*) Plant with calyptra.
(*e*) Calyptra of P. commune.
(*f*) Urn of the same.
(*g*) Ditto of P. undulatum.
(*h*) Mouth of the urn, shewing the peristome.
(*i*) Calyptra of the same.

very proper for the dusting of beds, curtains, carpets, hangings, &c. If these besoms were known to the brush-makers in town, it is probable they might come much into use for the purpose above mentioned." Such brushes are now very often made.

(779.) To the Laplanders the services of this moss are much greater than to us, for it affords them both "bed and bedding." They choose the starry-headed plants, out of the tufts of which they cut a surface as large as they please for a bed or bolster, separating it from the earth beneath; and, although the shoots are scarcely branched, they are nevertheless so entangled at the roots as not to be separable from each other. This mossy cushion is very soft and elastic, not growing hard by pressure, and if a similar portion of

it be made to serve as a coverlet, nothing can be more warm and comfortable. "Mollissimus est hic lectus cujus stragula undique ambiunt corpus et ad illud sese ubique applicant; calidissimus deinde est, ut virentis vegetabilis grati odoris, nec pediculos, pulices, cimices, scabiem, luem, aliudque contagium innocenti corpori adfert, nec plumulis undique obvolitantibus irresolubilibusque, cum inspiratione, pulmones infarcit phthisinque generat, sed lassum corpus molli grataque requiæ reficit." I have often, continues Linnæus, made use of it with admiration; and, if any writers had published a description of the simple contrivance of the Laplanders, (which necessity has taught,) I could almost imagine that our counterpanes were but an imitation of it. They fold this bed together, tying it up in a coil that may be grasped by a man's arm, which, if necessary, they carry with them to the place where they mean to sleep the night following. If it becomes too dry and compressed, its former elasticity is restored by moisture. *Polytrichum commune* is slightly astringent, but is not now used here in medicine. In Germany it is esteemed as a sudorific. At one time it was famed for promoting the growth of hair; which it doubtless does as effectually as the modern celebrated nostrums.

(780.) SPLACHNACEÆ. All the *true Mosses* with dehiscent thecæ, and which have only a single peristome, are included in a common type, called, from *Splachnum*, the normal genus, the

Splachnum ampullaceum.

(*a*) Two plants, natural size.

(*b*) Urn magnified.

(*c*) Leaf ditto.

(*d*) Urn of S. sphæricum, shewing the stoma and single peristome; the columella and the dehiscent operculum.

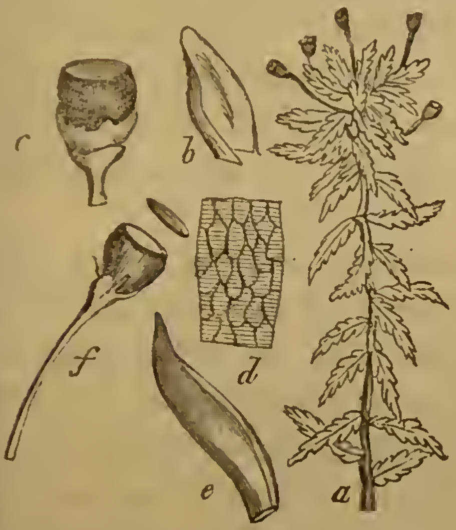
(*e*) The mitral calyptra.

Splachnaceæ. The genera thus associated differ, however, from each other in three particulars. *Fissidens* and *Leucodon* have *lateral Thecæ*, in the rest the *thecæ* are terminal; but in *Tortula, Dicranum, Conostomum*, and others, the calyptra is *dimidiate*, while in *Splachnum, Grimmia, Tetraphis*, and *Encalypta*, it is mitral. These variations, therefore, form the three subtypes

Splachnidæ, *Tortulidæ*, and *Fissidentidæ*, which the type *Splachnaceæ* comprehends.

It must however be borne in mind, that all these distinctions are only relative, and that osculant genera and species continually occur, which denote the connexions of the several groups, and the unity of the whole: thus, in the *Splachnidæ*, Grimmia unicolor, like all the other Grimmiæ, has, when young, a mitriform calyptra, but when mature, the calyptra becomes dimidiate. This peculiarity was, I believe, first noticed by Dr. Greville.

(781.) Sphagnaceæ. *Sphagnum*, which, with its allies, *Gymnostomum*, *Anæctangium*, &c., form the last type in this section;



Sphagnum.

(*a*) S. obtusifolium, reduced.

(*b*, *e*) Leaves magnified of two varieties.

(*d*) Portion, to shew cellular structure.

(*c*) Urn, with torn base of the calyptra, or vaginule.

(*f*) Urn, with operculum, both shewing the stoma destitute of peristome and the operculum.

from the normal genus it is called *Sphagnaceæ*, and is differentially known by all the genera it includes, being destitute of peristomes.

(782.) *Sphagnum* is a genus which differs from all other British mosses, by its perichætium being abortive, or rather, by the perichætial leaves not differing in form from the ordinary foliage. Hence, by some systematic writers, it is put into a primary group called "evaginulati," all those having perichætia being named Musci vaginulati. Here, however, the absence of perichætium merely distinguishes it as a subtype, called *Sphagnidæ*. The other genera in this type have *perichætia*, but in *Anæctangium*, the fruit-stalks are lateral, while, in *Gymnostomum* and *Schistostega*, they are terminal. Two other subtypes are therefore thus formed, called the *Gymnostomidæ*, and *Schistostegidæ*.

(783.) The *Sphagna*, or bog-mosses, are most abundant both in this country and in Ireland. They form excellent packing; and Mr. W. Curtis obtained a reward, from the Society of Arts, for his valuable discovery of the great advantages derived from the use of

these mosses for packing young trees for exportation. The sphagna are all of a singular chlorotic hue. By the Laplanders, Icelanders, and North American Indians, they are used for lining their neat and curious cradles. In cold countries they are also employed as a warm lining or stuffing for the loose deer-skin boots which the rein-deer drivers wear. It is said that no other lining is so surely a guard from the evil effects of frost. These mosses also form a soft elastic bed, which absorbs the moisture of the body very rapidly, and thus affords such a protection from the cold of a rigorous winter, that their place would be ill supplied by cloth; and, like the polytricha, whenever these couches get hard or lumpy, it is only necessary to plunge them into the next stream or pond, when the mosses resume their turgidity, and become as fresh and elastic as ever. It is indeed owing to the rapidity with which they absorb the cutaneous perspiration, as well as all other kinds of moisture, that these beds never feel damp, and retain their elasticity for so great a length of time.

(784.) The *Gymnostoma* are curiously minute and elegant plants, scarcely visible to the naked eye; but they well reward the microscopic researches of the diligent botanist. Haselquist observed G. truncatulatum growing in vast abundance upon the walls of Jerusalem, and hazards a conjecture that it may be the Hyssop of Solomon. That our present Hyssopus is not the plant alluded to by Solomon there can be but little doubt. If Haselquist's surmise should be correct, this minute "Hyssop, springing out of the wall," would contrast finely with "the cedar that groweth on Lebanon," and thus, by referring to the extremes of the vegetable world, the phrase, by a beautiful orientalism, would comprehend the whole of which the Chronicler says that the wise man spake.

(785.) The *Bryaceæ*, *Splachnaceæ*, and *Sphagnaceæ*, (the *Musci Gymnostomi*, *Aploperistomi*, and *Diploperistomi* of Hooker and Taylor,) which differ in their double and single fringes and want of peristome, but agree in the operculate dehiscence of their urns, thus constitute collectively the section Bryacinæ, which, with the two others, the *Phascinæ* and *Andræasinæ*, (the *Astomi* and *Schistocarpi* of the Bryologists just named,) are associated to form the order *Bryales*, the *Musci veri*, moor-worts, or true-mosses, of the generality of writers. The operculate theca is, as before said, the chief collective and differential sign; their habits, and the other characters already described, are, however, further confirmations of the alliance.

CHARALES.

(786.) Certain very curious water-plants vulgarly called *stone-worts*, but to which botanists have given the names of *Chara* and *Nitella*, form an order, that, from the normal genus, is termed CHARALES. The two genera just mentioned, into which the Charas have been distributed, and which include less than forty

A. Chara vulgaris; part of a plant to shew the axis and whorled branches. B. Small portion at a joint, magnified, to shew the numerous spiral striæ on the stem and branches. (*a*) The globule. (*b*, *b*) The nucules in the axillæ of the abortive foliage. C. Another portion still more enlarged, to shew the spiral valves of the nucule, and the course of the currents in the tubes. D. Transverse section of a branch, shewing the centre tubular cavity (*b*), and the meniscöid channels (*a*, *a*), in all of which the fluids move. (*c*) The lines of demarcation. E. Portion of *Nitella flexilis*. F. Smaller portion more enlarged, to shew the simple tubilles. G. Another portion, shewing the course of the rotary circulation in each cell or tubille. H, I. Longitudinal and transverse sections of the stem of *Chara hispida*. K, L. Gyrogonites, or fossil nucules, of Chara. M. Dissection of the nucule of Chara, shewing the outer coat formed of spiral valves, and the inner body or spore, with its spiral striæ. N. One of the valves of the nucule-case separate.

known species, are all that have been as yet discovered, and the whole that this order comprehends.

(787.) But, although thus few in number, their structure is so peculiar, that every attempt to associate them with other orders has failed: and even the propriety of their location among the mosses is not unquestionable. This arrangement, however, seems

to be the most natural that has been hitherto proposed; and, when their structure is morphologically compared with that of their allies, they will be found to be much less paradoxical than has been frequently believed. Still, that their affinities are obscure, is evident from the fact, that by some botanists they have been classed with flowering plants, and by others, of equal celebrity, and even by the same person, at different times, with those which are flowerless. Thus, by Linnæus, they were at first placed among the Algæ, near the Lichens, in the class *Cryptogamia*, but subsequently removed by himself to *Monœcia monandria;* and by later Linnæans, to *Monandria monogynia*, of the Phænogamic section. Even, in the present day, De Candolle and Leman have associated the Charas with the *Exogenæ*, Brown with the flowering, and Bartling with the flowerless *Endogenæ*, while Agardh, Walroth, Martius, and others, returning to the original opinion of Linnæus, fix them among the Cellulares; some, however, esteeming them allies of the confervaceæ, and others as a distinct group more or less remotely connected with the mosses. Thus, Lindley excludes them, although leafless, from his *Aphyllæ**, and associates them with the true mosses and liverworts, as the connecting links between the Hepaticæ of his tribe *Muscöideæ* and the *Confervine algæ*. Their affinities, however, are perhaps more complex; for notwithstanding, by their evascular axis, they are systematically connected with the mosses, their submersed habits and the internal structure of their stems, bring them close to the Confervales: while their leafless verticillate branches must be considered adumbrations of the equisetine ferns. With this view of their three-fold alliance they are here placed next to the most decidedly axial mosses, and on the confines of the classes leading to the order Equisetales of the Ferns; not, however, as an example of a lineally progressive rise in organization, but as a proof, by their connexion with the Algæ, that no such linear series naturally exist: for the various groups of plants resemble rather the geographical distribution of a country, where each district is bounded by several others, than the successive windings of a majestic stream, which at one part of its course may be named the *Isis*, and at another may be called the *Thames*. Thus, although the simply tubular structure of Nitella reminds the botanist of the simplest confervaceæ, the regularly whorled branches and the decided axis both of this plant

* A tribe containing the Lichens, Fungi, and Algæ.

and of Chara, bring them towards the Equisetaceæ, or horsetail ferns, while their double fructification and still cellular structure, shew their affinity to the mosses, and justify their association with them.

(788.) The Charales are leafless plants; by which circumstance, as well as by their whorled branches, they are distinguished from the *Bryales* and *Hepaticales:* and there are no other orders with which they can be confounded.

(789.) The fructification of the stoneworts consists of organs called *nucules* and *globules* [§ 786, B; *a*, *b*]; the first, formed externally of five spiral valves, terminating in five points, (an unusual number among cellular plants,) and containing one large sporule; the tegument of the *globule* is formed of numerous scales fitted to each other, and it contains many elastic filaments. Walroth says that the globules will germinate; and that they, as well as the contents of the nucules, will propagate the plants.

CHARINÆ.

(790.) CHARACEÆ. It is not improbable that other plants will hereafter be discovered which will connect the Charas already known more closely with the contingent groups to which at present they shew a somewhat distant relationship. If so, other types and sections may be included in the order; but, at present, *Chara* and *Nitella*, which were once combined in a single genus, form, together, the solitary type *Characeæ*, the only one in the section *Charinæ* which stands alone in the order *Charales*. The characters therefore of the order, section, and type, are all the same, viz. a distinct stem, or general axis of growth, with whorled processes resembling branches, destitute of leaves, but bearing minute bristly projections, which may be considered an abortive foliage, or rudiments of leaves. They are therefore separately named only in obedience to the supremacy of system, and for the purpose of rendering the distribution of this class consonant with that of others.

(791.) The genera *Chara* and *Nitella*, once united, are distinguished from each other by the stem and branches of the latter being formed of single tubils [§ 786, fig. E, F, G], while those of the former consist of many, [§ 788, fig. A, B]. The various species of both genera are found in the sea, in salt-marshes, and in fresh water. The *Charæ* are subject to a peculiar calcareous incrustation of their stems, (whence their name, stoneworts;) from this incrustation the Nitellæ are for the most part free.

(792.) The quantity of carbonate of lime which is deposited by vital agency within these plants is very great; indeed, so great, that the entire form of the plant remains after all the organic membranes have been removed. The ditches and ponds in which they grow are also often seen to have strata of considerable thickness formed at their bottoms, merely by these plants, and the chalk that they elaborate or collect. Among the fens in Cambridgeshire, the *Characeæ* are adding, year by year, earthy matter in abundance, to solidify and elevate the low and swampy soil.

(793.) The most interesting circumstance connected with the Characeæ is, that, owing to the extreme tenuity and transparency of their teguments, aided by their sap, containing numerous small opaque masses of Globuline, the motions of their fluids can be ocularly demonstrated, and, by the aid of a microscope, their course be satisfactorily traced. These motions have lately been shewn in a great number of other plants; but the Characeæ are interesting, not only from being the first in which they were clearly seen, but also from the phenomenon being the most easily exhibited in them.

(794.) The figures B, C, F, and G [§ 786], are magnified views taken from the drawings of Messrs. Varley and Slack, in which the courses of the currents round the cellules are shewn by the direction of the arrows. The currents in the different cells or tubils, although no communication exists between them, are continued in the same line throughout the branch or the entire plant. The ascending current in the branches is always farthest from the stem or general axis, the descending one nearest to it. In the Nitellæ these motions can be seen with a lens of $\frac{1}{15}$ inch focus without any previous preparation: in the Charæ, the calcareous incrustations, of course, most be removed.

(795.) The *Characeæ* have a peculiar and disagreeable smell, but very little taste: none of them are known to be noxious, neither are any medicinally or dietetically employed. Hence it is evident that they are not the plants to which Cæsar refers under the name of Charæ, for they afforded *eatable roots*, upon which, in a period of scarcity, the Roman soldiers fed.

These roots, the historian says, were eaten either mixed with milk, or made into a kind of bread. During the civil war, they at one time very greatly relieved Cæsar's forces, which, he writes, were in Spain much straitened in their supplies of ordinary provisions; and, when Pompey's soldiers exultingly spoke of famine,

those of Cæsar, as a practical denial of their distress, frequently threw loaves of Chara-bread among the enemy's ranks. (*De Bello Civili*, l. iii. c. 40.)

(796.) The three orders Charales, Bryales, and Hepaticales, form, collectively, the class *Musci*. They are associated by the evolution of leaves or branches on a distinct stem or axis; and by these associating characters they are distinguished from the Fungi and the Algæ, to which, by their cellular structure, they are otherwise allied.

(797.) The class being small, one table will suffice to give a summary of the types and sections included in its several orders.

Class.	Orders.	Sections.	Types.
Musci.	Charales	Charinæ	*Characeæ*
	Bryales	Phascinæ	*Phascaceæ*
		Bryacinæ	*Sphagnaceæ*
			Splachnaceæ
			Bryaceæ
		Andræsinæ	*Andræaceæ*
	Hepaticales	Hepaticinæ	*Marchantiaceæ*
			Targionaceæ
			Ricciaceæ.

(798.) Attempts have been made, and not without success, to reduce the successive developments just described, as marking the several sections and orders of this class, to the laws which regulate the evolution of special organs in higher grades. Morphologically considered, the thallöid frond of Riccia is a dilated axis, and the immersed thecæ, sessile fruit buried by the coalescing sub-latent foliage. In the Targionaceæ, the partial axis or fruit-stalk becomes lengthened and distinct, but the foliage is still combined with the stem or general axis. In the Marchantiaceæ, the shoots become more and more divided into lobes; and buds are formed upon the dilated stems within processes of the foliaceous stalk of Marchantia, which are called *origomes, i.e.* within the axillæ of whorls of leaves, as they are in Jungermanniæ in the axillæ of normal leaves. The dehiscence of the urns or thecæ, shew at once their foliar structure; and perhaps the eight-valved urn of Marchantia, the four-valved of Jungermannia, the two-valved of Anthoceros, and the one-valved Monoclea, indicate by their constant separation into the same number of parts, the number of leaves of which they are composed; and the transition from ordinary leaves to valves, is marked by the modified foliage which forms the perichetia, or calycels, and calyptra: the perichetia being only a whorl of leaves more or less developed, and sometimes, as in Riccia, latent or abortive; the Calyptra is another whorl, at first coalescent by their edges and apices, and forming a covering for the urn. Through this covering the urns of Riccia never protrude; those of Jungermannia, as their pedicles lengthen, burst through the slight canopy which continues to surround the base of the thecapode, forming an inferior calyptra.

(799.) The structure of the Bryales may be understood in a similar manner;

but the fruit is here something more complex. The *Perichætium* and *Calyptra* are, as in the liverworts, to be considered as modified leaves; but here the calyptra leaves are so firmly united that the urn, when raised by the growth of the thecapode, instead of bursting through the calyptra, rends the organ from its base, and carries it upwards, still as a cover for the fruit, while the small portions which remain below form a ring or slight sheath, called the vaginule.

(800.) The foliaceous origin of the opercula and the entire urns will scarcely be denied, if the pertinency of the foregoing remarks on the thecæ of Jungermannia be allowed, and especially if the valvular dehiscence of Andræa be borne in mind. The urn, as Lindley observes, should be considered more analogous to a flower than a capsule; it is analogous to the fruit in the rose, which contains the seeds, as it does the spores, and the one is surrounded at the margin with calyx and corolla, as the other is by a single or a double peristome. The sporules of the mosses are, however, only equivalent to naked seeds; and hence the columella must be the continuation of the common axis. Indeed, the sporules are probably buds developed by the columella, as gemmæ are developed in the axillæ of leaves on the lower part of the common axis.

In the Charales a marked change occurs. The axis is more decidedly developed, branches are given off in whorls, and the foliage is abortive, or rudiments of leaves alone appear in the form of hairs. But the nucules and globules, like the urns or thecæ, are formed of valves, which may be considered whorls of leaves. Too little is, however, known of the fruit of these plants, to permit the analogy in all parts to be clearly traced.

(801.) The arithmetical progression previously adverted to, when demonstrating the structure of the Algæ, is quite as evident among the mosses as among the flags: *e.g. Monoclea* has a one-valved, *Anthoceros* a two-valved, and *Jungermannia* a four-valved theca. Tetraphis has a four-toothed, Splachnum an eight-toothed, and Encalypta a sixteen-toothed peristome. In Grimmia, the peristome consists of sixteen equidistant teeth, entire, perforated or cleft, which leads to Didymodon, which has a peristome of sixteen double teeth, *i. e.* teeth cleft, but united at the base and arranged in pairs; and that conducts to Trichostomum, which has sixteen double teeth, cleft to the base. In *Funaria*, where the peristome is double, both the outer and the inner have each sixteen teeth. In Hypnum, Bryum, and Hookeria, the outer has sixteen teeth, the inner consists of a membrane incised into sixteen segments. In Bartramia the segments are thirty-two, or rather, there are sixteen that are bifid. In Orthotrichum, when ciliary processes are present, they are either eight or sixteen in number. In Fontinalis, Neckera, and Anomodon, they are sixteen likewise, the outer peristome having sixteen also; and in Polytrichum the teeth of the outer peristome amount to sixty-four: whence indeed its name, alluding to their number.

(802.) In the Bryales, it will have been observed that not only an arithmetical progression prevails, which is common to them with many other plants, and that the prevalent numbers are multiples of each other, but that they are ruled by a power of four. Tetraphis has four teeth to its peristome, which is the smallest number of divisions in any known moss. The numbers in other mosses are eight, sixteen, thirty-two, sixty-four, and there are no intermediate ones; which is not the case with the urn-valves of the liverworts, nor with the numbers noticed in the Algæ and the Fungi. Throughout all the three classes of this region, the

number two and its multiples prevail; but in the Bryal mosses alone is it a power of four.

(803.) Less attention has been lately paid to these numbers in the organic world than their regularity would seem to demand. Future examples, to be given in the other classes in which three and five are the numerical elements, will prove that they are not merely curious coincidences. But, as it would be premature to draw on these for illustrations now, reference may be made to the acknowledged importance of numerical or definite proportions in modern chemistry. Astronomy also affords many curious proofs of its importance; for it long since marked out the orbits in which the new planets Juno, Pallas, Vesta, and Ceres, then unknown, have lately been discovered to revolve; and it even now foretells the discovery of other satellites to Jupiter, and traces the very paths in which they will be found to move. The one prediction has been verified, the other waits to be fulfilled.

(804.) With respect to their direct utility to man, or in ministering immediately to his wants, it is evident, from the previous observations, that mosses do but little, unless, with the excellent Lightfoot, we admit among the *direct utilities*, that entertainment and agreeable instruction they afford to the contemplative mind of the naturalist, at a season when few other plants offer themselves to his notice.

For, as Johnston well observes, it is most curious to notice how gay these little mosses are on every wall-top during the winter months and in early spring, almost, or perhaps the only things which seem to enjoy the clouds and storms of the season. They choose the most exposed situations, spread out their leaves, and push up their glossy capsules amid rains, frost, and snow, and yet there is nothing in their tender and loose structure, from which we could *a priori* infer their capability of resisting influences so generally destructive to vegetation. But so it is: the more simple the organization of plants, the stronger is their tenacity of life; and its phenomena are exhibited and called into play by stimulants, not only very feeble, but apparently the very reverse of those necessary to excite plants of a higher order. Thus, mosses and lichens, overstimulated by heat and dryness, wither away in summer, but vegetate freely at a season when there is no other vegetation, and when their humble fronds cannot be overshadowed by a ranker growth.

Or, to quote the words of Linnæus, of which the preceding may be esteemed almost a paraphrase:

"Cum omnia circa nos torpescunt, et languescunt, cum flumina rigent, nemora silent, campi latent nivibus obtecti, ubique luctus, rerum facies decolor et tristis mortis imago: Musci inter vegetationis ruinas emergentes et sericeo colore fulgentes, rupes et lapides obducunt."

(805.) It is true that, were we not so abundantly provided with not only the necessaries, but also the luxuries of life, mosses might be applied to a variety of economical purposes, some few of which have already been adverted to. But although, from our wants being otherwise supplied, we make little use of mosses, it must not be

forgotten that, in the general economy of nature, and in ministering remotely to our advantage, few plants are of more real and absolute importance. Even shortly to enumerate the whole of the indirect utilities of these plants, would be an arduous task; let therefore a slight reference to a few alone suffice.

(806.) Mosses gradually fill up and consolidate bogs, and form rich vegetable mould for the growth of larger plants, which they also protect from cold during the winter. Mosses likewise clothe the sides of lofty hills and mountain-ranges, and by their filamentous structure very powerfully condense the watery vapours floating in the atmosphere, and thus become the living fountains of many streams. These plants, and their immediate allies, the liverworts, which often appear to have so suddenly clothed a barren heath, or overspread a dry wall with verdure, have the peculiar property of remaining in a dormant state for a very considerable length of time, and to revive from their parched condition as if awaked from sleep, on the access of moisture, to all their pristine beauty, spreading abroad their delicate leaf-like expansions and their beautiful apologies for blossoms.

(807.) In elegance and delicacy of structure, mosses are not exceeded by any plants that grow; and an intimate examination of these minute vegetables would almost, if not altogether, lead the observer to believe that, however admirable nature may be in every particular, yet that, in excess of modesty, she veils her chief beauties from the vulgar gaze, and reveals them to those true lovers alone who are strictly wedded to her service and her study. Perhaps a higher tribute to their beauty was never paid than that which springs from the detail Mungo Park has given, of the consolation and encouragement he received, in a period of great difficulty and danger, from the contemplation of the inimitable structure of one of these lowly mosses. As an illustration of the wholesome effect of the study of the works of nature on a well-regulated mind, the passage, although often quoted, cannot be deemed unworthy of repetition. This enterprising traveller, during one of his journeys into the interior of Africa, was cruelly stripped and robbed of all that he possessed by banditti. In this forlorn, and all but hopeless condition, he says, when the robbers had left him, "I sat for sometime looking around me with amazement and terror. Whichever way I turned, nothing appeared but danger and difficulty. I found myself in the midst of a vast wildnerness, in the depth of the rainy season, *naked* and *alone*, surrounded by savage animals, and men still more savage. I was five hundred miles from any European settlement. All these circumstances crowded at once upon my recollection; and I confess that my spirits began to fail me. I considered my fate as certain, and that I had no alternative but to lie down and perish. The influence of religion, however, aided and supported me. I reflected that no human prudence or foresight could possibly have averted my present sufferings. I was indeed a stranger in a strange land, yet I was still under the protecting eye of that Providence who has condescended to call himself the stranger's friend. At this moment, painful as my reflections were, the extraordinary beauty of a small moss irresistibly caught my eye, (I mention this, to shew from what trifling circumstances the mind will sometimes derive consolation;) and, though the whole plant was not larger than the top of one of my fingers, I could not contemplate the delicate conformation of its roots, leaves, and fruit, without admiration. Can

that Being (thought I) who planted, watered, and brought to perfection, in this obscure part of the world, a thing which appears of so small importance, look with unconcern upon the situation and sufferings of creatures formed after his own image? Surely not. Reflections like these would not allow me to despair. I started up; and, disregarding both hunger and fatigue, travelled forwards, assured that relief was at hand, and was not disappointed:"

—— "Thus, to apprehend,
Draws us a profit from all things we see."

GEOGRAPHICAL DISTRIBUTION OF THE MUSCI.

(808.) Mosses are very widely spread over the surface of the globe. The earth shoots them forth in almost every variety of situation; and, so that the locality be moist, or occasional access can be had to moisture, scarcely any other circumstance seems essential to the growth of these humble, beautiful, and useful plants. For, as they in general absorb their nourishment chiefly from the atmosphere, soil is to them of little comparative importance; and many appear reckless both of heat and cold. They are found at the lowest depths of vallies, and are met with on the highest alps. They extend even from the confines of perpetual snow to the burning sands of the torrid zone.

(809.) But the three orders into which the mosses have been distributed exhibit very different powers of resisting and enduring atmospheric vicissitudes; and gradually change a watery for an aerial station.

(810.) The *Charales*, although geographically distributed to the full extent of the other orders, are, in their topography, much more restrained. They are essentially water-plants, and always grow submerged. They are most abundant in temperate countries; but, like many other aquatic tribes, are very widely spread, occurring both in salt and fresh water: sometimes in rivers, but more frequently in stagnant ditches, pools, and lakes, in almost every part of Europe, Asia, Africa, Australia, and both Americas.

(811.) The *Liverworts* equal the other mosses in the nominal extent of their geographical range, being natives of every quarter of the globe: but though not all, nor wholly, aquatic plants, they are intolerant of extreme aridity. Hence in Africa very few are met with, while in damp shady places, whether in hot or cold climates, they are abundant; they are, however, the most numerous in temperate regions. The Ricciæ are part of them aquatic, and part of them terrestrial plants.

(812.) The Bryales are chiefly aerial plants; and in them the third station becomes established, for they will endure extremes of dryness which would exterminate most other plants. In newly formed countries, where soil can scarcely be said to be, these mosses, the *servi* of Linnæus, are found labouring in legions; amidst the scoriæ of volcanoes they rear the standard of vitality, and cover the strata of cinders with a coat of vegetation. They are most numerous in moist and temperate countries, but they are spread from the equator almost to the poles. They are among those plants which, as they will endure extremes of heat, are also the last that yield to the rigours of perpetual winter: for we learn that, even in New South Shetland, " the black and lifeless soil is covered with specks of mosses struggling for existence," and that they are plentiful on the otherwise barren rocks of Spitzbergen.

(813.) Of the geographical distribution of the different types and sections of this order little can be at present said; for, although many of the 970 known species appear to be proper to particular climates, while others seem to be cosmopolites, still the established facts are as yet too few to justify any sweeping generalizations.

(814.) The numerous species of Hypnum, the most extensive genus in the class, are so very abundant and so generally dispersed, that a botanist of repute believes it would be " no exaggeration to say, that they form *a fourth part* of the vegetable clothing of this island. They are met with everywhere. In many old pastures they usurp the place of the more useful grasses: they form a large proportion of the vegetation of moors: they flourish at hedge-bottoms, in woods and deans, on rocks, and even on sand-links; and they grow in profusion in every marsh, and bog, and stream. The share they thus contribute to the green covering of earth is very considerable; especially in winter, when they are in their greatest perfection," and when they are the most wanted, not for ornament alone, but for the protection of other plants, and the preservation of myriads of insects which otherwise might perish. Whether or not Johnson's data fully warrant the conclusion he has ventured to draw with regard to the proportion of these mosses in this country, it is well known that Musci form upwards of a fourth part of the entire flora of Melville Island, and probably of many other places similarly circumstanced.

(815.) The minute sporules which constitute the seeds of mosses can alone account for their universal distribution, and their constant presence even on the most distant and most barren spots. Bare rocks raised from the bosom of the sea, torrents of lava which convert fruitful fields into barren wastes, bogs, marshes, and mountain-tops, are all covered by mosses, and their allies and fellow-labourers, the lichens, because there they most are wanted, and there they work to the most advantage.

GEOLOGICAL DISTRIBUTION OF THE MUSCI.

(816.) Five fossil species of Chara, and one, or at the most two, fossil mosses, are all that have been as yet discovered. No vestige of a fossil liverwort has hitherto been found. It is true, as

A. Muscites Tournalii, reduced. B. Portion magnified. C. Hypnum riparium. D. Portion magnified. E. Leaf separated. F. Muscites (?) squamatus. G, H. Portions magnified. I. Sphagnum compactum. J. Separated leaf of ditto. K. Branch of Juniperus phœnicea.

Brongniart observes, that Daubenton believed he had recognised a variety of these plants in the moss-like markings of Agate; and Mr. M'Culloch published, in the Geological Transactions, several figures having a very strong resemblance to Jungermanniæ. But Brongniart, after much laborious investigation, concludes that they are simply infiltrations, accidentally assuming forms which, without very attentive examination, might be mistaken for vegetable impressions.

(817.) That the stoneworts should be found in a fossil state from the first epoch of their existence, might be presumed from the dense incrustation with which they surround themselves; petrifaction being to them a natural process, that terminates their life. But, although abundant in the beds above the chalk, their first appearance is in the lower fresh-water formation. The fossil

nucules of the Chara, [§ 786, K, L,] were called by Lamarck *Gyrogonites;* but later naturalists considering the fossils to be remains of plants identical with those now existing, they of course must have the same denomination. The stems and fruit of fossil Charæ are very common in this country; and beautiful specimens are procured from the Scotch marl, and from the lakes in Forfarshire, where they are most abundant.

(818.) Of the two species of Muscites, one only is absolutely decided to be a fossil moss; the other, which at first was thought to be a Lycopodium, although now called a Muscites by Brongniart, has a query attached to its generic name.

The Muscites squamatus, [fig. E, G, H,] has long been known under the name of Lycopodites, as occurring in the mill-stone quarries near Paris.

The Muscites Tournalii, [fig. A′, B,] has been but lately discovered by M. Tournal, near Narbonne, in a fresh-water formation, consisting of chalk marl, and forming part of the tertiary series.

The former, Brongniart considers to bear a stronger likeness to the Hypnidæ than to any other mosses, and he gives a figure of *H. riparium*, [fig. C, D, E,] to shew the similitude of the leaves; at the same time pointing out various other resemblances to other species, such as *H. ripariöides*, *cuspidatum*, *denticulatum*, and *elegans*. The latter more doubtful fossil he likens to the *Sphagna*, some of the fragments bearing the greatest resemblance to *S. compactum*, [fig. I, J,] and others to *S. squarrosum*. The regularity of the four ranks in which the leaves of the Junipers are arranged, [fig. K,] will at once separate them from these remains, with which otherwise they might be confounded.

(819.) It is a remarkable fact, as Brongniart justly observes, that the most jealous scrutiny has failed to detect the slightest indication of Muscites in the coal formations, though the epoch in which the plants which form those strata lived appears to have been favorable to a vegetation resembling that which is now in many parts of the world accompanied with the growth of mosses. It is indeed most curious, that the earliest traces of any of these plants should occur at so late a geological period, when it is considered that the Charales will grow both in salt and fresh water, that the Bryales require no soil at all, and how tolerant they are of heat and cold.

(820.) The mosses therefore afford another proof of the weakness

of the doctrine of progressive development; for, notwithstanding the simplicity of their structure, their epoch of appearance is long, very long after that of palms, pines, ferns, and other higher vegetables.

(821.) Two different schemes of structure have already been described as being each characteristic of one of the two preceding classes; both of which set out from nearly similar simple beginnings, but pursue, in their developments, quite opposite courses.

(822.) In the Algæ or Flags, the organs of vegetation predominate, and the constant tendency is expansion into leaves or leaf-like members; so that, although true foliage is never formed, even the stems are phyllöid, or foliaceous.

(823.) In the Fungi or Mushrooms the reverse occurs, for the fructification is pre-eminent; the plants sometimes consisting of fruit alone: and no tendency is ever observed towards the production of leaves. On the contrary, the nisus is towards the extension of the plant into an axis or stem, which, in the *Clavariæ*, and some of the higher fungi, is developed in considerable perfection: and, whenever expansions are produced, as in the *pilei* of the Boletales, and especially in the *lamellæ* of the Agarics, they are the very antipodes in resemblance to ordinary leaves; so that the Fungi are peculiarly aphyllous plants, while the Algæ are foliaceous, or rather pseudo-phyllous ones.

(824.) The Musci or mosses, though in very many respects unlike either of the foregoing classes, would seem to be regulated in their evolution by both those powers in a nearly equal degree which were respectively predominant in the Fungi and the Algæ; and, as the result of this compound influence, they combine a regularly developed axis or stem, with ramifications or foliar appendages. The axis and its radial appendages being for the most part distinct, and not blended into an obscure mass, or forming a doubtful organ, which may with equal propriety be considered as either leaf or stem, as both or neither.

(825.) The Mosses, regarded as a series, exhibit some further most beautiful gradations, the structures, the textures, and the members, becoming progressively more and more various, and less and less blended with each other. In Riccia the whole plant is most decidedly a *frond*, but little raised, except in its hue, above the condition of a *thallus;* for the plate or layer of cells, of which the organ of extension is composed, projects from its

under surface radical fibres, and within its upper, conceals the organs of reproduction. From Riccia, which often presents but a simple disc of vegetation, and connects the Liverworts through Endocarpon with the Lichens, the course may be pursued through Marchantia, where the frondose expansions are greatly sinuated and the urns elevated—to the Jungermanniæ, some of which entirely lose the frondose character and assume the *surculus*, which is present in all the Bryales. In the mosses the expanded projections of the axis, which are called leaves, are frequently found conjoined, shewing that the union of the whole would constitute a frond; just as the minute division of the frondose membrane forms the leaves. In the Hepaticæ the cellules are rounded or nearly so, and no such thing as a *rib* is to be seen traversing the expansions, even in the foliose Jungermanniæ, and the rudimentary axis or rachis of the frondose species, is in some abortive. In the *Bryales*, the cellules become more and more elongated, nervures or ribs are formed upon the leaves, and filamentary projections extend beyond the margins, which, being the continuations of the mid-ribs, are called excurrent nerves. In the Charales, the cellules are so much extended that they must be regarded as tubilli, and they mark the transition of cells into tubes, or the change of vesicles into vessels, commonly so called; thus carrying this region to the confines of the next. Indeed, in Sphagnum, and one or two other instances, it is asserted that tubular vessels have been found, as well as fibro-membranous cells, which are the rudiments of spiral tubes; Hooker also discovered in some few cases perforations in the leaves, which have since been shewn by Mirbel to be true *Stomata;* organs which had previously been supposed to be confined to the following classes.

(826.) True Stomata are generally signs of tubular vessels existing within the plants upon which they are found; and, when the development of both is confirmed, a remarkable change occurs, not only in the organic elements of which the plants are composed, but also in their external configurations, external form being most frequently an index to internal structure.

(827.) Upon these important structural peculiarities depends the distribution of the whole vegetable reign or kingdom into the three chief regions, already named, and described, in the Introduction. The ALGÆ (or *flags*), the FUNGI (or *mushrooms*), and the MUSCI (or *mosses*), using these terms in their familiar and extended acceptations, and including in each class the several orders specified, constitute, collectively, one of these great groups or regions, viz. that which, from the simply cellular structure of the plants it comprehends, has received the

common appellation "CELLULARES," *q. d. Plantæ Cellulosæ.* The anatomical discovery that certain plants are formed of cells alone, while in the tissues of others both tubes and cells are combined, in various manners, has afforded some most important differential signs to the systematic botanist; and one of the chief bonds of union of the three classes associated in this region is their unvaried cellular structure. It is however essential to add, that they are *flowerless* as well as cellular plants; because, in several instances, the tubular vessels become obsolete in genera and species, such as *Nayas, Rafflesia,* &c. which are flowering plants, and undoubtedly allied to the tubivascular series. The name *cellulares* thus becomes exceptionable, and the older terms, *Acotyledones, Sporiferæ,* &c. are still less admissible.

(828.) Hence, for the above reasons, as well as for those explained in the Introduction, it has been proposed to call these classes, collectively, the *Moss* or *mustallies* (Mycaffines), which is, in reality, little more than the restoration of the derivatives to the original signification of their common roots, [§ 64—66.]

(829.) In the synthetic association of the orders contained in these classes, and the various types and sections they respectively include, it has been attempted to bring together, as far as the present state of science will permit, those plants which are the most nearly allied in structure, and to let the characters of the several groups result from their association. Such was the avowed principle acted on by Linnæus, in the construction of his genera and other natural groups; and such is the only legitimate path to be pursued in the development of the so-called natural methods of arrangement. Hence, as every part is necessarily examined, the details are diffuse; and, as organs vary in their importance in various plants, the differential signs are often changed, sometimes being founded on the fruit, sometimes on the foliage, and at others upon neither.

(830.) But although, for far nobler ends, the natural method sacrifices the simplicity and singleness of an artificial scheme, which is only designed to be an index, it is not wholly destitute of analytic powers; and it is satisfactory to observe, how often the associating characters of the several groups can be made practically useful as differential signs. The following table will illustrate this position; and, though essentially imperfect as an index, from the *chief* characters alone being given, and the exceptions that occur in the osculant groups, still it will not be abused by those who understand the respective values of the natural and artificial schemes; and reference can readily be made to the previous pages for the other characters which could not be condensed into the space of a tabular conspectus. A secondary advantage may also result from such a summary concluding each of the three great divisions of the vegetable world; for it will shew how easily the most important indicative characters of the classes and natural orders may be remembered, and in how few words the chief differences of even the sections and subordinate types may be expressed, when one small page contains the whole.

	Classes.	Orders.
MYCAFFINES. Flowerless cellular plants.	MUSCI. Leafy or branched, axis developed	*Charales*, leafless, branches whorled. (9)
		Bryales, foliose, urns operculate. (8)
		Hepaticales, chiefly frondose, deoperculate. (7)
	FUNGI. Leafless or aphyllous	*Boletales*, hymenium present. (6)
		Tuberales, h. absent; fungus pouch-like. (5)
		Mucedinales, sporidia naked. (4)
	ALGÆ. Foliaceous or pseudo-phyllous	*Lichenales*, aërial algæ. (3)
		Fucales, aquatic inarticulate algæ. (2)
		Confervales, articulate algæ, chiefly aquatic. (1)

MUSCI.	9.	CHARINÆ.	*Characeæ.*	Axis much developed, branches whorled, leafless.
	8. BRYALES.	PHASCINÆ. Urn indehiscent	*Phascaceæ.*	Operculum persistent, urn indehiscent.
		BRYACINÆ. Operculum deciduous.	*Sphagnaceæ.* *Splachnaceæ.* *Bryaceæ.*	Peristome absent. ——— single. ——— double.
		ANDRÆASINÆ. Urn dehiscent by valves.	*Andræaceæ.*	Opercle persistent, urn dehiscent by valves.
	7.	HEPATICINÆ. De-operculate, chiefly frondose.	*Marchantiaceæ.* *Targioniaceæ.* *Ricciaceæ.*	Urns calyptrate, dehiscent. Urns veil-less, dehiscent. ———, indehiscent.
FUNGI.	6. BOLETALES.	AGARICINÆ. H. distiuct, ascigerous, inferior.	*Agaricaceæ.* *Boletaceæ.* *Auriculariaceæ.*	H. lamellar, or plicate. H. sinuate, porous, or subulate. H. tuberculate, papillose, or smooth.
		HELVELLINÆ. H. distinct, ascigerous, superior.	*Helvellaceæ.* *Pezizaceæ.* *Clavariaceæ.*	H. not marginate, receptacle cap-like, open. H. margined, rec. not cap-like. H. not margined, amphigenous, rec. elongated.
		TREMELLINÆ. H. blended with the receptacle. Asci none.	*Cyphellaceæ.* *Exidiaceæ.* *Tremellaceæ.*	H. iuferior, rec. dry. H. superior, rec. irregular. H. obscure, amphigenous.
	5. TUBERALES.	TUBERINÆ. Sporidia in proper discrete receptacles.	*Phallaceæ.* *Tuberaceæ.* *Nidulariaceæ.*	Receptacle discrete, sporidia in a mucous stratum. Sporidia in membranous sporangia. Sporangia free, peridium discrete.
		BOVISTINÆ. Peridium not discrete, sporangium without a nucleus.	*Bovistaceæ.* *Spumariaceæ.* *Sclerotiaceæ.*	Peridium distinct, figure determinate. Per. spurious, figure indeterminate. Per. connate, or confounded with sporangia.
		SPHÆRINÆ. Perithecia nucleiferous.	*Sphæriaceæ.* *Phacidiaceæ.* *Xylomaceæ.*	Per. ostiolate, nucleus ascigerous, diffluent. Per. dehiscent, asci discoid, erect, fixed. Per. crowded with sporidia.
	4. MUCEDINALES.	TUBERCULARINÆ. Sporidia simple; receptacle solid and persistent.	*Ceratiaceæ.* *Dermosporiaceæ.* *Tuberculariaceæ.*	Receptacle floccose, figure various. Rec. smooth, subspherical, sporidia incumbent. Rec. roundish or flattened, sporidia subdiffluent.
		MUCORINÆ. Sporidia free, fixed upon, or bursting through a simple peridiolum.	*Stilbiaceæ.* *Mucoraceæ.* *Acremoniaceæ.*	Peridiolum thin, fugacious, stipulate, not discrete. Per. distinct, inflated. Per. like sporidia, fixed to flocci.
		MUCEDINÆ. Receptacle floccose, sporidia scattered, soou free.	*Botrytiaceæ.* *Fusidiaceæ.*	Flocci of two forms, septate. Flocci uniform.
		UREDINÆ. Minute parasites, bursting through the cuticle of the plants bearing them.	*Sporodesmiaceæ.* *Nemasporaceæ.* *Uredinaceæ.*	Stroma genuine. Str. spurious; growing on dead plants. Str. none; chiefly on living plants.
ALGÆ.	3. LICHENALES.	BYSSINÆ. Thallus filamentary, fructification uniform.	*Byssöidaceæ.* *Byssaceæ.* *Rhizomorphaceæ.*	Spores and sporidia obsolete. Flocci free or subdiscrete. Flocci concrete.
		VERRUCARINÆ. Apothecia closed and nucleiferous.	*Verrucariaceæ.* *Pertusariaceæ.*	Thallus crustaceous, excipuli proper. Excipuli thallöid.
		CETRARINÆ. Apothecia opeu, disciferous.	*Graphidaceæ.* *Parmeliace.*	Excipuli when present, proper. Excipuli thallöid.
	2. FUCALES.	FUCINÆ. Fronds more or less densely fibrous, nigrescent, sporidia dark or black; all marine.	*Lichinaceæ.* *Fucaceæ.* *Laminaceæ.* *Sporochnaceæ.* *Chordariaceæ.* *Dictyotaceæ.*	Frond dense, conceptacles porous. Fr. fibrocellular, olive green, becoming black on drying. Fr. dense, hue little chauging. Fr. tufted, dark, not very variable. Fr. solid, threadlike, round. Fr. reticulate, mostly ribless.
		FLORINÆ. Fronds membrauous, or cartilaginous, colour brillinut, little changing; sporidia purple: all mariue.	*Furcellaceæ.* *Spangiocarpaceæ.* *Floraceæ.* *Gastrocarpaceæ.* *Caulerpaceæ.* *Thaumasiaceæ.*	Fr. uot fibrous, sporidia pyriform. Sporidia wedge-shaped, sori spongy, wart-like. Frond leafy, hues brilliant, little changing, spores sorate or ternate. Fr. ribless, veinless, gelatinous within. Fr. green, membranaceous, creeping. Fr. reticulate, ribs rigid, fragile.
		ULVINÆ. Sporidia colourless or green, fronds mostly membrauous. Fresh-water, sea, damp soil.	*Lemaniaceæ.* *Ulvaceæ.* *Siphonaceæ.*	Fr. coriaceous, fruit internal. Fr. membraneous, fruit internal. ———, fruit exterual.
	1. CONFERVALES.	CONFERVINÆ. Articulations within a tubular thallus.	*Ceramiaceæ.* *Conferraceæ.* *Oscillaceæ.*	Fruit external. ——— internal (eudochrome) th. not gelatinous. Fr. interual iu masses septate, th. subgelatinous.
		NOSTOCHINÆ. Thallus jelly-like, form definite, not fragile.	*Rivulariaceæ.* *Nostochaceæ.*	Thallus globose often filiform, fil. annulate. Thall. globose, cells dispersed, or moniliform.
		FRAGILLINÆ. Thallus abseut or obscure, plauts very fragile.	*Fragillaceæ.* *Globulinaceæ.*	Cells for a time connected, fragile. Cells soon disarticulating.

OUTLINES OF FILICOLOGIA.

(831.) The *Club-mosses* or *Foliose-ferns*, [§ 68, E, F, § 840, 843, 847,] (SELAGINALES ;) the *Brakes* or *Frondose-ferns*, [§ 68, A, B, C, § 852, 859, 863, 881,] (PTERIDALES ;) and the *Shave-grasses* or *Leafless-ferns*, [§ 68, D, § B,] (EQUISETALES,) form, with their respectives allies, three natural orders, which, by being tubivascular flowerless plants, are associated in a common group, or class, denominated FILICES or FERNS. [§ 68.]

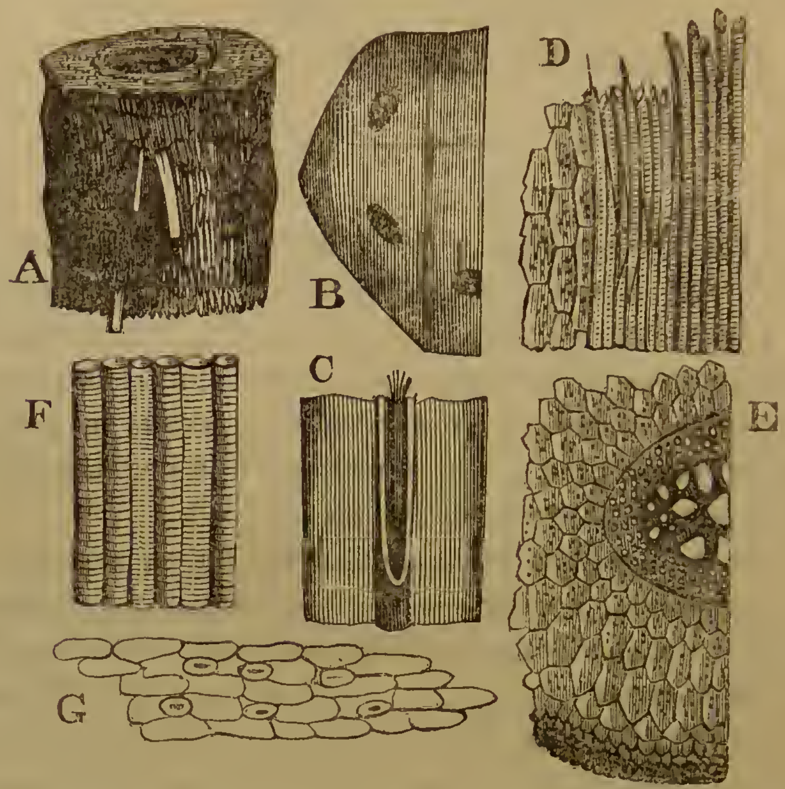
(832.) It is more than probable that the Greek synonyme *Pterides*, [from πτερον, a wing,] was given originally to only one of these orders, viz. the Brakes or Frondose-ferns, which have winged fronds as a common character; and that the Latin *Filices* [from *filum*, a thread,] belongs of right to the filamentous shave-grass ferns alone. But usage has made both terms synonymous, and applied them, oftentimes indifferently, to every order. Sometimes, however, they have been confined exclusively to the Brakes or wing-like ferns; and at others they have been made into distinct appellations, by various prefixes and suffixes, while the simple words have been regarded as common collective terms. Thus the Club-mosses have been called *Rhizo*pterides or *Bryo*pterides, root or moss ferns; the Brakes, *Phyllo*pterides, foliaceous or frondose ferns; and the Shave-grasses *Stachyo*pterides or *Gony*opterides, *i. e.* spiked or jointed ferns.

But neither these nor other similar words and phrases, such as *Filices Spicatæ*, *Dorsiferæ*, *Epiphyllospermæ*, &c., have been generally adopted; and *Equisetum*, *Pteris*, and *Selago*, old and well-known names, which are still retained by some of the most common and familiar examples of the several groups, afford perhaps preferable denominations.

(833.) The ferns are tubivascular flowerless plants; and the latter part of this definition at once distinguishes them from the other classes with which, by the former, they are allied. Because they are cryptogamic, some persons would regard them as evascular, and notwithstanding their structural peculiarities and their palm-like port would associate them with the mosses, the fungi, and the algæ; but such an arrangement anatomical investigations absolutely forbid.

(834.) In the first place, the tegument of these plants differs widely from that

of either of the previous classes, by being furnished with distinct and regular openings, called *mouths* or *stomata*, which are characteristic of a true cuticle;



A. Transverse section of the stem of an arboreous fern, showing the hollow centre, and the coating of adventitious radicles. B. Aspidium Filix mas. Transverse section of half the petiole to show the fascicles of fibres and tubes, surrounded by minutely cellular substance. C. Longitudinal section of one of the fascicles. D. Small portion very highly magnified, to show the annulate structure of the tubes. E. Small portion of the section B much magnified, to show the cellular structure and transverse sections of the tubes forming the fascicles. F. Annulate tubes from the stalk of Lycopodium denticulatum. G. Portion of the cuticle of the same plant, showing its areolations and stomata.

a texture not to be found in the mosses, flags, or fungi, their tegument, when any is evolved, being simply an *ep-enchyme*, or condensation of cells similar to those beneath it, and seldom possessing stomata.

(835.) In the second place, a transverse section of any of these plants will shew that their internal structure is as different from the internal structure of the previous classes as the *cuticle* that invests it is from the parenchyme; for, instead of the simple homogeneous cellular substance of the mosses, flags, and fungi, there is found among the cells one or more fascicles of lengthened tubes, [§ 834, B. C. D. E.] formed either of simple membranous tunics, or of longitudinal series of tubils extended into the tubes, and which are ordinarily called vessels, although a cell is a vessel as much as a tube, from which it differs only in its form; and, in the common and proper acceptation of the word, perhaps the cup or cistern which receives the fluid has a better right to the denomination *vessel*, than the tube or pipe through which it passes; for *vas, vasculum, vasello, vaiselle*, mean rather the reservoirs that contain, than the channels that transmit.

(836.) But, provided that the fact of this difference be clearly known and un-

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derstood, it matters little whether the continuous channels be called tubes, tubular vessels, or vessels only; although perhaps the latter word had better be used collectively to include both kinds. These tubes, when examined, are found to differ in their structure, being either perforated with many pores, or thickly set with minute corpuscules, constituting the corpusculiferous tubes of Dutrochet, or the perforated vessels of Mirbel. Along with these corpusculiferous tubes other tubes are met with, the structure of which is different; they seeming to consist of a series of coalescing rings, or rather of helices, the successive turns of the spiral threads of which, lying close upon each other, form a tube, which tubes are called spiral tubes, or tracheæ; but when, as in these plants, the turning of the helices are so connected as not to be able to be unrolled, they are called false spirals, or false tracheæ, to distinguish them from those which readily untwist, and which are named tracheæ, or true spirals.

(837.) These plants therefore consist of cellular texture intermixed with tubular vessels, and are covered by cuticle; and tubular vessels never being known to be present without the cuticle being furnished with stomata, leads to the belief that stomata are very rarely present without being accompanied by tubular vessels. Indeed, in almost every plant that has been carefully examined, they have been found to be accompaniments of each other. Some few exceptions are however known. *Marchantia* and *Targiona*, which by their stomata anticipate a character of this succeeding class, and thus strengthen the union of the whole, are two already noticed, [§ 760;] and *Isoetes* (840,) one of the *Selaginales*, is another. But, with regard to this latter, it is not improbable that, if the dissection of its stem and leaves was more accurately performed than opportunity has hitherto allowed it to be, some traces of vessels would be found in them, as the stomata are so highly developed. The tubes would, however, be expected to be in a more rudimentary state than in *Lycopodium*, [834 F.G.] because this genus seems to be but a humble aquatic ally of the Wolf's claw-wort, and nearer the transitional line which runs between the evascular mosses and the tubivascular ferns.

SELAGINALES.

(838.) The *Selago* of the British druids (if indeed the herb which now bears that name be identical with the plant so much prized by them,) was formerly, with its allies, the fox-tail and wolf's-claw worts, from their general resemblance to mosses, considered as such; and hence indeed their common names of *Club-moss*, *Fir-moss*, and *Mountain-moss*.

Modern research has however shewn that, although in the transitional group or district they are essentially different from mosses, both their organs of vegetation and fructification decidedly associate them with ferns. Hence they have been removed from the preceding class, and placed in this; and hence also the Selaginales are now called foliose, moor, or mossy ferns.

LYCOPODINÆ.

(839.) *Lycopodium*, the wolf-claw wort, and *Isoetes*, the quill wort, are the normal genera which give names to the two types

Lycopodiaceæ and *Isoetaceæ*, which this section comprehends. They are associated and distinguished from the next section by their stems being foliose, and by the spores being contained in axillary thecæ, which are either dehiscent, or, if indehiscent, enclosed within the bases of the leaves. In the *Lycopodiaceæ* the thecæ dehisce by valves; in the *Isoetaceæ* they are enclosed within the bases of the leaves, and are indehiscent. The Lycopodiaceæ have a lengthened axis: in the Isoetaceæ the axis is abortive, and the foliage crowded in radical whorls upon a reduced stem called a *cormus*, [§ 840, *a*, *b*.] They have both the habits and appearance of mosses, while their fructification is decidedly that of ferns.

(840.) Isoetaceæ. In *Isoetes*, the quill-wort, the organs of fructification are small cases, called conceptacles (*conceptacula*), situated in the angles formed by the union of the leaves and the contracted stem (*cormus:*) those in the axillæ of the outer or infe-

Isoetes lacustris, the lake quill-wort.

(*a*) Entire plant, half the natural size.
(*b*) Transverse section near the bases of the leaves, shewing the enclosed organs of fructification.
(*c*) Front view of one of the external leaves, shewing its conceptacle.
(*d*) Side view of the same.
(*e*) Transverse section of the conceptacle, shewing its three cells filled with granules.
(*f*) The same, the granules having been removed.
(*g*) Longitudinal section of one of the inner conceptacles, shewing its numerous cells filled with grains.
(*h*) Ditto, grains removed.
(*i*, *i*) The grains very much magnified.
(*j*) Section of a leaf, shewing its lengthened cells.
(*k*) Another section of the same.
(*l*) Cuticle of the lower surface of the leaf, with stomata.
(*m*) Cuticle of the upper surface.

rior leaves are divided into three cavities, containing about fifty spherical bodies called *granules;* the cases in the axillæ of the internal or superior leaves are divided by numerous transverse partitions into many cavities, which are all of them filled with an impalpably fine powder, in the early stages of its development white, but subsequently becoming black. These conceptacles are enclosed by the bases of the leaves, and are indehiscent; which

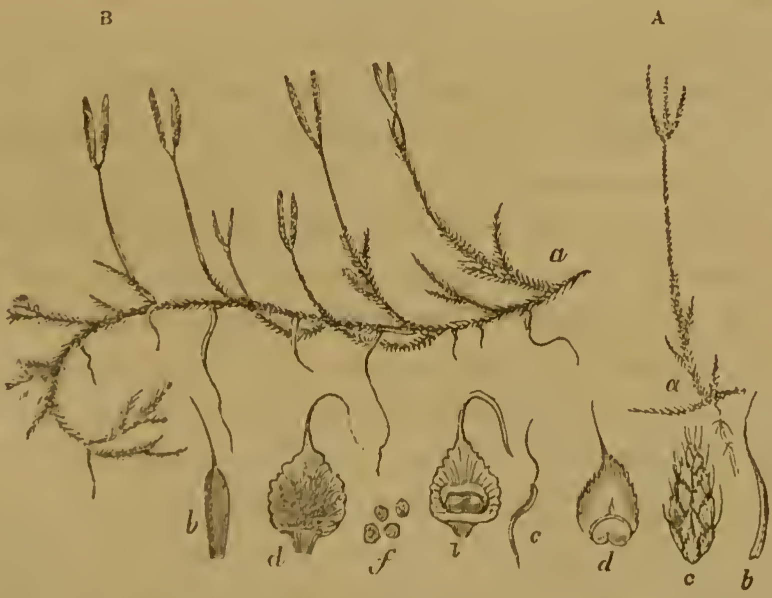
characters will easily distinguish the Isoetaceæ from all other types.

(841.) The name *Isoetes* is derived from ισος and ετος, alluding to the evergreen state of these plants, giving them an *equal* beauty throughout the *year*. They grow at the bottoms of lakes, and are said to afford excellent food for fish. They have been called quill-worts, from the rush or quill-like appearance of the leaves.

(842.) This genus has been commonly associated with several others, to which indeed it has a general affinity, under the name *Hydropterides* or *water ferns*, but from some of them it so decidedly differs, that, although they might well be arranged in the same section, they can scarcely with propriety be kept without further distribution, or be included in the same type. Hence, Bartling removed Isoetes from the Lycopodiaceæ, where it was located by De Candolle, Brongniart, and others, to join it with the pepper-worts (Marsileaceæ), a group to be immediately described, but to which its affinities are not more obvious, if so close; and therefore it had better constitute by itself an intermediate or border type, under the name of Isoetaceæ.

(843.) LYCOPODIACEÆ. The axis, which in Isoetes is contracted into a mass called *cormus*, on which the leaves are thickly set, like the leaves or scales of a *lily*, or other bulb, so as to form a tuft, is, in Lycopodium and its allies, lengthened, and the leaves distributed along its course, which often extends to several feet.

Lycopodium.



A. *Lycopodium selago.* (*a*) Portion of the moss-like frond. (*b*) A leaflet of the fruit stalk separate. (*c*) Apex in fructification. (*d*) Bractea, with conceptacles in the axilla.

B. *Lycopodium clavatum.* (*a*) Trailing moss-like stem. (*b*) A leaflet of the fruit stalk separate. (*c*) A hair-like mucro. (*d*) External side of a bracte. (*e*) Internal surface, with conceptacles in the axilla. (*f*) Granules separate.

The conceptacles or coques are sessile, situated in the axillæ of the leaves, and, as in Isoetes, are of two kinds; the one including larger, the other smaller bodies. The smaller are considered by some as anthers, or pollen cases, and contain a fine yellowish dust called pollen; the larger corpuscles are alone believed to germinate, and to be the true *granules*. The anther conceptacles open by two, and the granule conceptacles by four valves.

The granules, when examined, do not exhibit within them any very perceptible traces of distinct organs, such as a rudimentary stem or radicle; although, by some botanists, the two small leaves which they first form have been named cotyledons; and Brotero describes a little oily body within the granule as a *vitellus*, but De Candolle rather considers it to be a cotyledon. These parts are however too obscure, and have been too little examined, to allow them at present the names which belong to much more highly developed organs: they would seem to be rather precursors of the cotyledons, anthers, &c., than really such, just as the flattened caudal extremities of the Cetacea and the Seals are rather transitions towards legs, than really feet.

(844.) The *Lycopodiaceæ* comprehend only two, or at the most three, well-marked genera, viz. *Lycopodium* [§ 68, E, F; § 843,] the wolf-claw-wort, *Psilotum* [§ 847, A,] or *Bernhardia*, the naked moss-fern, and *Tmesipteris*, the cut-fern. The two last-named are objects of interest here, rather from their rarity than their beauty: the former, in many of its species, is extremely common on many of our upland heaths and alpine moors. The Selago (Lycopodium selago) was once famed as a powerful remedy in diseases of the eyes, whence indeed, according to De Theis, it received its name, which is derived from the Celtic SEL, *sight*, and JACH, *salutary*. It is even now, in the Highlands of Scotland, made into an irritating ointment, which is applied with advantage to the neighbourhood of the eyes as a counter-irritant. This unguent is also employed to dress foul ulcers, and might be used for keeping blisters open instead of savin. Internally administered, the selago acts violently as an emetic and cathartic. The Highlanders, we are told, notwithstanding, give it in infusion; but, if the dose is not very small, it is followed by serious giddiness and convulsions. Linnæus says, the Swedes find a decoction of this herb serviceable as a detergent lotion, and in destroying the vermin that often infest swine and other animals; the Poles also state, that a decoction of another species, the *L. clavatum*, [843, B,] is more successful than any other means yet known in the treatment of that dreadful disease *Plica polonica*. Both the species just named, as well as the *L. complanatum*, &c., are used in various places instead of alum, to fix the colours of certain dye-stuffs; with Brazil-wood, they form a beautiful and permanent blue. The *Pollen* or *granules* of *L. clavatum* are

collected in large quantities, and known in the market as vegetable sulphur. This dust is used for the purpose of ameliorating wine. It is also employed as an absorbing powder, to prevent excoriations in young children; but its chief consumption is in pyrotechny, for the utter impalpability of the powder causes it, when set fire to, at once to be consumed; hence it is in great request at theatres, for the purpose of producing artificial lightning.

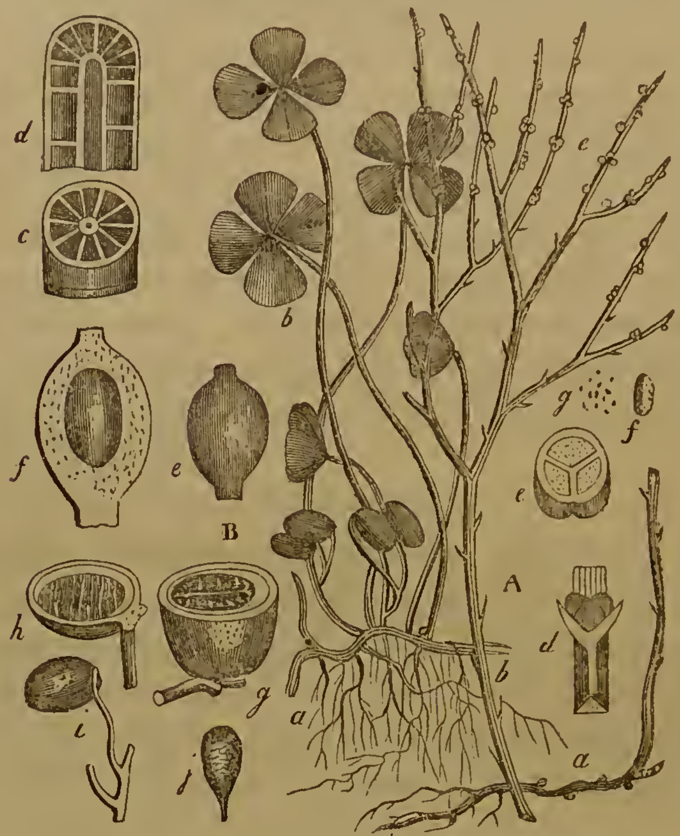
(845.) The two types now illustrated, viz. the *Isoetaceæ* and *Lycopodiaceæ*, form, together, the section *Lycopodinæ*, which, as the best known, has been the first described, although perhaps not the lowest of the moss-ferns, the Pepper-worts having more the structure of the Hepaticæ than these of the *Bryales*.

MARSILINÆ.

(846.) *Isoetes*, which by some Filicologists is associated with the present rather than the preceding section, marks the transition from the one to the other, and connects the two. The chief distinctive characters of this section are, that, in both the types, the conceptacles are free and indehiscent; for in the Lycopodinæ, when free, they are not indehiscent, and when indehiscent, they are not free.

(847.) Marsileaceæ. The *Pill-wort* (*Pilularia*), with its congener (Marsilea,) the pepper-wort, are associated in a type named Marsileaceæ, and known by their free conceptacles being sessile in the axillæ of their leaves, like the *Lycopodiaceæ*, and not enclosed in the bases of the petioles, like *Isoetaceæ;* from both of which they are, however, further distinguished by their uniform fructification and circinate vernation. The conceptacles are of one kind only; they are seated in the axillæ of the leaves, which are scattered along a lengthened prostrate stem; they are indehiscent, and contain at the upper part of their cavities sessile corpuscules, which are considered analogous to anthers, as they emit a yellow dust or pollen; and below these, in the same conceptacle, are other sessile but larger corpuscules, which have been called pistils, each crowned with a minute point, which has been named the stigma. Each of these corpuscules becomes a monospermous or one-grained fruit, which, during germination, protrudes first a radicle and then a leaf, which are subsequently increased into a tuft of each, the first leaf being considered by some persons to be a cotyledon; of which organ it is probably a repre-

sentative or proxy. The granules contained in the conceptacles of Pilularia and Marsilea are of two kinds, being analogous to the



A. *Psilotum triquetrum*. (*a*) Root. (*b*) Stem and branches. (*c*) Fructification. (*d*) Section of stem with leaves and axillary fruit. (*e*) Horizontal section of the fruit. (*f*, *g*) The granules magnified, and of the natural size.

B. *Marsilea quadrifolia*. (*a*) Rootlets. (*b*) Leaves. (*c*) Section of pedicle. (*d*) Longitudinal section of the same. (*e*) Fruit. (*f*) Ditto, with part of the tegument removed, to shew the reproductive body. (*g*) Transverse section of a conceptacle, to shew the two sorts of contained granules. (*h*) Conceptacle cut lengthwise. (*i*) Stalk, bearing a conceptacle. (*j*) One of the granules supposed to be a stamen.

larger and smaller granules found in the separate conceptacles of *Isoetes:* the smaller granules are situated at the superior, the larger at the inferior parts of the conceptacles; and, although probably differing only in degree of development, have received the names, the superior, of *anthers*, the inferior, of sporidia or granules.

(848.) Salviniaceæ. *Azolla*, a New Holland plant, and *Salvinia*, are contained in a type, called, from the normal genus, *Salviniaceæ*. They are known from the Marsileaceæ by the conceptacles being dimorphous, *i. e.* of two kinds, as in *Isoetes*, but free in the axillæ of the leaves, not included in their bases; and from the *Lycopodiaceæ*, by their being indehiscent. These con-

ceptacles contain the two sorts of corpuscules already described in the allied sections, and which are said to germinate with similar phenomena; but they require further examination.

(849.) Collectively the two types, *Salviniaceæ* and *Marsileaceæ*, constitute the section *Marsilinæ*, which, with the *Lycopodinæ*, including *Isoetaceæ* and *Lycopodiaceæ*, are the only two into which the foliose or Moss-ferns (Bryopterides or) Selaginales, have been hitherto distributed. Their solid, leafy, or not frondose stems, and radical or axillary fructification, associate this section, and distinguish them as an order from the other ferns. To the Pteridales they are most closely allied, by their non-fistular axis, jointless stems and branches, and circinate vernation, but their leaves, and the negative character of being not dorsiferous, will readily distinguish them from an order which has been sometimes differentially described as the Epiphyllospermæ or Filices dorsiferæ.

PTERIDALES, OR FILICALES.

(850.) The *Lycopodiaceæ* of the moss-ferns not improbably pass on one side by the vegetation of the naked claw-wort (Psilotum), and by the spiked conceptacles of the club-moss to the *Equisetaceæ* or shave-grasses; indeed, by Willdenow they were put together, and called by him the 'Stachyopterides,' or spicate ferns: but, as the linear tract a history pursues cannot always follow the devious path that nature loves, it will be more convenient to describe the frondose ferns the next, and to conclude the class by a notice of the jointed ferns, which have many affinities with the grasses. The peculiar vernation of the *leaf-ferns*, which is *circinate, i. e.* folded inwards as if the fronds were rolled upon themselves, clearly points out their affinity with the preceding order, in which a similar disposition prevails; and, as it is rare, it becomes an important feature, connecting the Selaginales and the true ferns with the Zamiales of the Zapini; a distant order, and yet one in which it would seem that nature, while perfecting a higher internal organization, had fallen back upon herself, and repeated the external form of a lower grade.

(851.) The frondose ferns, *Pteridales*, (called likewise Phyllopterides, Filices dorsiferæ, or Epiphyllospermæ,) are probably those which the translators of Linnæus had in view when they rendered his synonyme, *Novaccolæ* or colonists, *Gipsies*, from the circumstance of these plants, like gipsies, bearing their offspring on their backs. They are by far the most numerous and familiarly known of all the ferns; and indeed, by some persons they have been considered as

the only true ones; but it seems better that the common name should include the whole in one class, as was done by Linnæus and Jussieu, and a subsequent distribution distinguish the several orders.

(852.) The ferns of this and other temperate regions are comparatively humble plants, their true stems generally creeping on the surface of the earth, as in the *Lycopodiaceæ,* or even being subterranean, as in most of the frondose ferns, the parts which are usually considered stems being in reality only branches; but in the West Indies, in St. Helena, the Isle of Bourbon, and other hot insular situations,

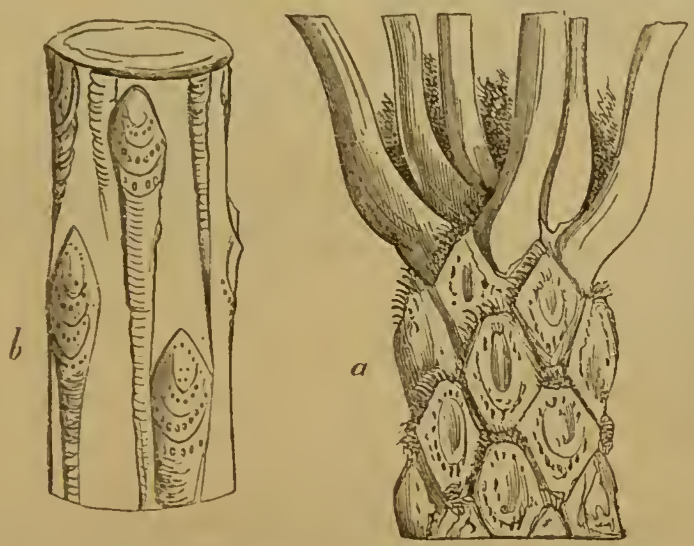
Cyathea glauca, and other arboreous ferns, natives of the Brazils and of the Isle de Bourbon.

arboreous species are found, the stems of which rise out of the earth, and elevate their crown of fronds to the height of twenty, thirty, or forty feet, or even more. In the British Museum is a stem of *Alsophila,* brought to England by Dr. Wallich, that measures forty-five feet; but seventy or eighty feet are occasionally attained. In these noble examples of the class, the true structure of the stem and affinities of the plants in general with palms, and even with cycases and pines, is much more obvious, even to the common observer, than in the suffruticose and herbaceous brakes that are now indigenous to these northern latitudes. Even the Aspidia or shield-ferns, which do form a dwarfish stem and collect their fronds into a crown, hold only the same comparative rank to the arboreous species as onions or lilies do to palms; or our herbaceous cresses to our forest-trees; and the ferns with subterranean stems, like our eagle-brakes and horsetails, are only to be compared with the tree-ferns in the same way in which fodder-grasses are compared to canes and towering bamboos, or rushes to the loftiest palms.

(853.) Hence, among ferns, there will be found the same modifications of the

vegetative organs, as, among other plants, some are herbaceous, some under-shrubs, some scandent like woodbines, and others sturdy and arboreous, like ordinary trees.

(854.) The stems of ferns, like those of palms, and most other plants in the two following classes, which by many points of structure are associated with them, maintain an equal diameter throughout their entire height [§ 852]; but a curious circumstance has been noticed by Brongniart, viz. that, although the stems do not vary in diameter, they continue extending lengthwise even in the oldest parts; a

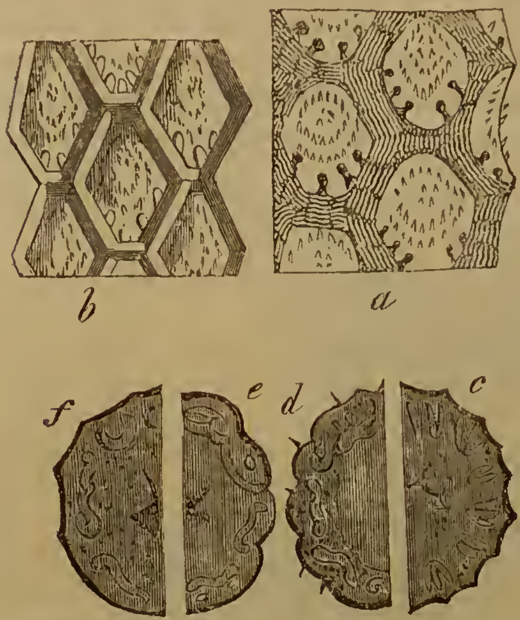


Upper and lower parts of the stem of *Cyathea arborea,* from Haiti, shewing the greater distance of the scars on the lower part (*b*,) than on the upper part (*a*); thus proving the growth even of the oldest portions which are constantly extending in height, as marked by the increasing distance of the scars.

fact which is proved by the gradual recession of the leaf-scars from each other; for, in the upper and younger portions, as at (*a*), they are crowded as closely as the fronds could be exserted, while at (*b*,) a section from the lower part of the same stem, although once as close, they have become gradually more distant.

(855.) The frondose-ferns or brakes, (Pteridales or Filicales,) have the cuticle furnished with stomata even more abundantly than the mossy ferns, and the structure of their stems becomes still more characteristic of that region of the vegetable reign or kingdom in which they are arranged; for, not only are the fascicles of tubes often more numerous, [§ 834, fig. B, C, D,] but among them there have lately been discovered, by a very skilful vegetable anatomist, Mr. Valentine, true tracheæ or spiral vessels, capable of being unrolled, which marks another ris e in this gradual series of developments. The fascicles of tubes and fibres seem to be on the whole less uniform in their arrangement in the frondose ferns, than in the Selaginales; but, although they are very variously arranged in different examples, each species maintains a constant similarity in their disposition. In the common Brake (*Pteris aquilina*), they somewhat resemble a two-necked spread eagle, whence indeed that plant derives its specific name, and other species exhibit other forms [vide fig. *c, d, e, f*], some of which have been likened to various letters, and others to elaborate ornamental figures. This similitude of internal structure does not extend to the genera into which the species are now collected. These fibro-tubular fascicles, which give the chief strength to the stems and fronds, and,

by their dispersion, form the rachis and costules of the foliaceous expansions, are embedded in cellular structure, which in the fronds is chiefly external, and in the stem chiefly internal; so that the stem of an arboreous fern very much resembles



(*a*, *b*,) Marks left by the decayed fronds on the stems of tree-ferns, forming a spurious bark.

(*c*, *d*, *e*, *f*,) Transverse sections of the stems of various ferns, to shew the irregular distribution of the fascicles of tubes.

that of a palm, not only from its permanent cylindrical form, but also in the harder parts being external, and the centre being either hollow, or filled with a soft pulpy matter, which is often eaten as food, like the soft pulp of the sago-palm. Although the fascicles are collected into more regular figures in the ferns than in the palms, they are never distributed into strata of wood and bark, nor is the parenchyma disposed in radiating plates, extending from the circumference to the centre. They have indeed neither true wood nor true bark, their stems being unstratified. In prostrate and subterranean Stipites, roots proceed in abundance from the lower sides, while the fronds or branches are developed on the upper. In arboreous ferns this tendency to protrude adventitious roots from all parts of the stem, is often very evident, [§ 834 A,] and the descending fibres sometimes form a kind of adventitious shaggy tegument, which apparently increases the lower part of the stem to three or four times its absolute diameter, and gives it a conical character. In the perennial creeping stems, the original roots and rootlets die, and the plants successively form new ones, the old ones progressively decaying; they however, in some cases, are persistent through many years, and have been traced ten or fifteen feet in length, or even more.

(856.) When the cormus, which in *Isoetes* is small and insignificant, becomes elongated, as in the underground creeping or climbing stems of Pteris aquilina, Lygodium scandens, or *climbing snake's-tongue*, or still more in the Dicksonia arborescens, Cyathea arborea, and other tree-ferns, it is denominated a stipes, and from it the fronds proceed, the foot-stalks of which have unaccountably usurped the name that belongs properly to the stem alone. The fronds, which represent foliage and fruit conjoined, are formed by the divergence of the fibres of the stem or *stipes*, and the foot of each branch is generally, as above stated, called *stipes* also; *peridrome* has been substituted by some filicologists, but perhaps stipitella would be a better term.

(857.) The fronds are often spoken of as leaves; they, however, are not such, and have more the character of boughs or branches, the edges of which are expanded into membranous wings, as is not uncommon in plants still higher in the scale of nature: their power of producing roots, and being gemmiparous, although not absolutely conclusive, are, when combined with their characteristic peculiarity of bearing fruit, circumstances strongly corroborative of this opinion. These winged expansions, or fronds, are sometimes simple, as in the hart's-tongue (*Scolopendrium*), and saw-fern (*Xiphopteris,*) [§ 859;] at others more or less compound, according as the continuation of the stipitella, (which, as soon as the expansions begin, is called the Rachis,) is more or less divided, of which Aspidium, Pteris, &c. [§ 881, A,] afford numerous examples. The venation in the ferns is reticulate, and dichotomous as well as linear.

(858.) The backs of these expanded ramifications exhibit groups (sori) of fruit, which are borne upon their foliaceous fruit-stalks. These sori are sometimes naked, as in the wall-fern, the moon-wort, the royal osmund, &c. [§ 863, fig. *a*, 881, B, &c.] at others they are covered by a membrane called an *indusium*, as in *Scolopendrium*, *Aspidium*, &c. [§ 881, A.] Those sori which are naked are developed upon the frond exterior to the cuticle, those which are *indusiate* are formed beneath the epidermis which is raised by their growth, and the portion raised, which is of various shapes, according to the figures assumed by the heaps of conceptacles or sori, becomes the indusium. The indusium is sometimes single and sometimes double, and dehisces or opens either irregularly or regularly; all which differences afford more or less important distinctive characters of genera, types, and sections.

(859.) The sori [A, B,] consist of groups of cases or thecæ, called conceptacles, [C,] containing *granules*, and each thecæ is either surrounded by an extern

Xiphopteris (or *Grammitis*) *serratula.*

A. Entire plant with several fertile fronds, reduced. B. End of a frond with sori. C. Pedicelled thecæ, shewing the annulus to be a continuation of the pedicle. One conceptacle dehiscing and discharging the granules.

elastic ring called *annulus*, [§ 881, A, fig. *h*,] or is destitute of any such girdle, [§ 863, *f*, *g*;) the first sort of thecæ being named *annulatæ* or *ringed*, the second *exannulatæ* or *ring-less*. The thecæ are occasionally called sporangia or spore-

cases, and the *granules, spores*. These thecæ are sometimes formed of a single cavity alone, at others they are divided into numerous compartments or locules; and the very fine dust discharged when they open or dehisce, consists of the granules which germinate when moisture is present, and develop a small green body, which is regarded as a cotyledon, or at least, as the representative of one. De Candolle observes, that Bernard de Jussieu considered it as such when he placed the ferns among the Monocotyledones. The theca is believed to be a modification of the foliage, and the annulus the metamorphosed midrib.

(860.) Sir James Smith was the first botanist who proposed a really philosophical arrangement of ferns, and his scheme, although very defective, is undoubtedly the foundation upon which those of Swartz, Willdenow, Brown, Kallfuss, and others, have been raised. As the result of much collated labour, it would seem that the Pteridales, or winged ferns, should be distinguished into three chief sections, which, according to Hooker, can be advantageously reduced to two; in one of which the thecæ, or sporangia, are furnished with rings, and in the other are destitute of them; being the *Annulatæ*, or ringed, and the *Exannulatæ*, or ringless sections, of Smith; excluding however the moss-ferns, which he has retained among his Exannulatæ.

(861.) The most familiar genera of these two districts or sections are perhaps, of the former, *Pteris*, the eagle brake, or *Polypodium*, the many-footed fern; and of the latter, *Osmunda*, the flowering osmund, and *Ophioglossum*, the adder's tongue: hence these sections have been called the *Polypodinæ* and the *Osmundinæ*, as *Pteris*, the best known and most common of all, gives name to the order: Pterides being the collective term applied by the Greeks indifferently to all the frondose ferns they knew.

(862.) Both these sections admit further analyses, and have been variously subdivided. The latter contains two types, the *Ophioglossaceæ* and *Osmundaceæ*, each of which may be distinguished into two subtypes, concerning which there is little doubt. Such, however, is not the case with the former; for they differ in two points of organization. In some the conceptacles are *naked*, and in others they are invested with either a *single* or *double indusium*. Again, some have the conceptacles *stalked*, and others *sessile*, or nearly so. Neither of these differences alone being very essential, the *Polypodinæ*, although containing more than half the known genera of this the most numerous section in the class, are usually all retained in one type, as well as in one section. Yet, as this is practically inconvenient, it does seem advisable to seek some distinctive signs; and none are more easy of recognition than those afforded by the absence or presence of the *indusia* and *pedicles*. The genera may thus be distributed into three types; and it is not unimportant to mark, by their association, those genera which have no indusia from those which have, and those which have their conceptacles stalked from those in which they are sessile. The three types thus formed are, first, the *Polypodiaceæ;* second, the *Aspidiaceæ;* and third, the *Gleicheniaceæ*.

OSMUNDINÆ.

(863.) OPHIOGLOSSACEÆ. *Ophioglossum*, the adder's tongue, (*οφις*, a serpent, and *γλῶσσα*, a tongue,) gives name to this type, which also includes *Botrychium*, the moon-wort, and several tropical genera, called *Danäe*, *Marattia*, *Angiopteris*, and *Kaulfussia*. They are associated by the common characters of their *exannulate conceptacles being bivalved, adnate at the base, coriaceous, and opaque*. The four last-named foreign genera differ, however, from their associates by having their conceptacles plurilocular, and, although half-bivalved, dehiscing by a single longitudinal cleft: hence they are formed into a subtype, named the *Marattidæ;* while the others, in which the vernation is straight, and the thecæ are one-celled and open by two distinct valves, constitute the subtype *Ophioglossidæ*.

(*a, b, c*) *Botrychium Lunaria*, shewing the expanded barren fronds, and the contracted foliage of the fertile fronds.

(*d*) *Ophioglossum vulgatum*.

(*e*) The tumid base of the stem, or barren frond, of B. Lunaria, enclosing the fertile frond.

(*f*) Enlarged pinnule of the fertile frond of B. Lunaria.

(*g*) Ditto with the conceptacles open, to shew the bivalved dehiscence.

(*h*) The spores or grains, greatly magnified.

(864.) *Botrychium Lunaria*, the common moon-wort, was once believed, from the crescentic form of its barren fronds, to be endowed with peculiar powers, and to be especially marked out by nature as a plant under planetary influence: it is now known that its former reputation was wholly undeserved. *Botrychium virginicum*, which is a large American species, is there called the rattlesnake

fern, from its being the favourite resort of those venomous reptiles, and the coverts that it forms should therefore be avoided by travellers, or very cautiously approached.

Angiopteris evecta is an arborescent fern, found by Forster in the islands of the Pacific Ocean. In the Sandwich Isles the natives steep the bruised fronds in cocoa-nut oil, on account of their fragrancy; and they likewise use the roots as food, which they call *Nehai*.

(865.) Osmundaceæ. *Osmunda regalis*, the flowering fern, is the largest of all the at present existing British species: its name is of Saxon origin; *Osmunder* being one of the titles of Thor, the Celtic Thunderer, and *mund*, as in *Osmund, Edmund, Sigismund*, &c., is a well-known adjunct, signifying strength and power.

(866.) The *Osmundaceæ* are exannulate ferns, the conceptacles of which dehisce by a single longitudinal cleft. The conceptacles are likewise further contrasted with those of the *Ophioglossaceæ* by being pellucid and reticulate, or rayed, at the top.

(867.) *Todea* is an African fern, separated by Willdenow from *Osmunda*, and dedicated to the memory of Tode, a German mycologist. These two genera differ by their reticulated conceptacles opening only as high as a pellucid dorsal projection, from their allies *Aneimia, Lygodium*, &c., in which the striated receptacles open throughout their entire length. Hence two minor groups, or subtypes, have been proposed to be established, which may be called the *Osmundidæ* and *Lygodidæ;* of which the foregoing will be the distinctive signs.

(868.) The root of *Osmunda regalis* possesses astringent and styptic properties; it is said to be also tonic, and to have been found serviceable in cases of rachitis, but it is at present very little used. The variations common in the fronds of this plant afford excellent illustrations, with *Ophioglossum, Botrychium*, &c., of the contraction of the leafy portion of the frond, which often can be traced in every stage of abortion. The *Lygodia* are the best examples that can be given of scandent ferns. *L. scandens* and *circinatum* are East Indian plants; *L. palmatum*, a handsome North American climber.

(869.) The exannulate conceptacles of both the types *Ophioglossaceæ* and *Osmundaceæ* associate them in the section *Osmundinæ*, which is thus easily distinguished from the *Polypodinæ*, in which the conceptacles are invariably ringed.

POLYPODINÆ.

(870.) The plate or projection whence the radiated striæ proceed in the *Osmundaceæ* is morphologically considered to be the rudiment of the ring, which becomes developed as a distinctive character of the present section; and the transition is marked here by the border genera, *Parkeria* and *Ceratopteris*, or *Ellobocarpus*, having the annulus broad and zone-like.

(871.) The three types included in this section are named, from their three normal genera, *Gleichenia*, *Aspidium*, and *Polypodium*, the *Gleicheniaceæ*, *Aspidiaceæ*, and *Polypodiaceæ*; and in them the conceptacles are either sessile or stipitate, and the indusia either double or single, or absent. The common or associating character of the section is the annulus or ring with which each conceptacle is girded round.

(872.) Gleicheniaceæ. Some of the genera included in this type have been called *desciscent* ferns, and all of them excluded by Sprengel from his Filices veræ, nothing being more unsettled than the extent of meaning to be attached to the phrase *true ferns*, as used by various writers. This group, which is small, appears to be transitional from the exannulate section; for, like the *Osmundinæ*, the conceptacles are sessile or subsessile, (sessile in the majority of the genera, and very shortly pedicled in only one subtype;) the dehiscense is likewise for the most part regular in longitudinal clefts; and the annuli, although distinctly developed, are broad and zonate, not forming narrow sailliant rings, as in the two following types.

(873.) The *Gleicheniaceæ* afford examples of three progressive grades or stages of development, and are therefore distributed into three subtypes, called, from their respective normal genera, the *Gleichenidæ*, *Parkeridæ*, and *Hymenophyllidæ*.

(874.) Gleichenidæ. *Gleichenia*, *Mertensia*, and *Platyzoma*, shew an affinity to the *Osmundidæ*, by the capsules being occasionally subsessile. Their distinctive characters are the following: "conceptacles dehiscing by a regular longitudinal cleft, and surrounded by an entire broad elastic ring or zone, which corresponds with the attachment of the conceptacles."

Prince Maximilian, in his travels, states that the Brazilian negroes make the tubes of their pipes of the stalks of the *Mertensia dichotema*, which they call *Samanbaya*.

(875.) The genera *Parkeria* and *Ceratopteris*, or *Ellobocarpus*, form the next subtype, the *Parkeridæ*: the associating and distinctive characters of which are: "sessile conceptacles, dehiscing by a regular longitudinal cleft; ring broad, very short, and incomplete; and seminules few in each conceptacle."

(876.) The *Hymenophyllidæ*, that connect this type to the following, in which they are often included, are distinguished from it by their sessile conceptacles, irregularly dehiscing, their complete elastic annuli not corresponding with the insertion of the conceptacles. The two last-named characters also distinguish them from the two associated subtypes with which, by the former, they are allied.

Both *Trichomanes* and *Hymenophyllum* are extremely elegant ferns, the foliage being fine and membranous, and almost transparent. They have not as yet been applied to any useful purposes, and have hitherto baffled the art of the gardener, and refused to be domesticated as ornamental plants.

(877.) Aspidiaceæ. All the annulate dorsiferous ferns with indusia and stalked conceptacles are comprehended in this, which is the largest type of all. It contains about forty known genera, which are divided into two subtypes, in one of which, as in *Onoclea*, the indusia are double; in the other, as in *Aspidium*, they are single. The subtypes are therefore respectively named the *Onocleidæ* and the *Aspididæ*.

(878.) Onocleidæ. *Onoclea*, and its allies, *Struthiopteris*, *Vittaria*, *Diplazium*, &c., are *annulate*, *dorsiferous ferns*, having *double indusia*, *i. e.* the indusia or coverings are placed on both sides of the sori; hence they are distinguished, and form the subtype *Onocleidæ*.

(879.) The *Diplazia* are handsome ferns. *D. auriculatum*, a native of the Caraccas, is arborescent. *D. esculentum* is resorted to for food by the natives in Hindoostan. The *Struthiopterides*, as their name imports, have splendid fronds, bearing some resemblance to ostrich feathers. One species of Onoclea is of such delicate structure, and so impatient of mechanical violence, that, although it will bear our climate well, it withers if much handled. Hence it has received the name of *Onoclea sensibilis*; and some marvellous tales are told of its discriminating powers with regard to the innocence of the persons by whom it is approached.

(880.) Aspididæ. All the annulate dorsiferous ferns with single

indusia are comprehended in this, which is therefore a very large subtype. It contains many important genera, of which the following are examples: *Aspidium*, *Pteris*, *Asplenium*, *Blechnum*, *Lomaria*, *Lonchitis*, *Adiantum*, *Davallia*, *Dicksonia*, and *Cyathea*.

(881.) The Brakes or frondose ferns, are not very extensively employed by man, either as food or in medicine. One species only finds a place in our national pharmacopœias, although several are possessed of curative powers, and are esteemed officinal plants in

A. *Aspidium Filix mas.* (*a*) Upper part of the frond, shewing the rachis and pinnæ, reduced. (*b*) The lower part of the frond, shewing the rootlets springing from the horizontal stem, or common stipes, with the remains of the old stipitellæ; one in a mature state, and another young one, shewing the circinate, or crozier-like vernation. (*c*) A fertile pinnule, detached. (*d*) An indusium, removed with some of the conceptacles attached. (*e*) The granules, or sporules, discharged from (*f*, *i*) two conceptacles burst by the elastic power of the annuli; spores being discharged. (*g*) A conceptacle detached before dehiscence, to shew its pedicle and ring. (*h*) Ditto, in its natural position.

B. *Polypodium vulgare.* (*a*) Two mature fronds springing from the creeping stipes; also a young frond, shewing the circinate vernation. (*b*) Fertile pinnule, detached. (*c*) A pedicled annulate conceptacle, detached. (*d*) A group or *sorus* of conceptacles, without any indusium.

our provinces, and are entered by authority in the continental lists of the vegetable materia medica. Even the Aspidium filix mas, the

only fern our colleges retain, is very rarely used; and yet, from its having been celebrated as an anthelmintic from time immemorial, and more especially from its never having been lauded as a panacea, like many fashionable medicines, which run their course and are forgotten, but always possessing a certain degree of reputation, it is not unreasonable to believe that it deserves it; and, if so, that it does not merit the neglect that it meets with here. The so-called male fern was recommended as a vermifuge by Theophrastus, Dioscorides, and Galen; and its administration formed the ostensibly specific, if not the most energetic, part of the treatment recommended by Madame Noufer in cases of tape-worm. But it cannot be overlooked that she accompanied its exhibition with a strong dose of calomel, gamboge, and scammony, the very ingredients that formed the famous "Pulvis Trium Diabolòrum," and which were thought, in their alliance, to be powerful enough to discomfit even a more stubborn enemy than tænia.

(883.) The Scythian or Tartarian lamb [vide § 5,] is a species of Aspidium. Of this fern so many wonderful tales have been told, and supported by such evidence, that the world has doubted whether to discredit or believe them. Struys, who travelled through Russia, Tartary, &c., in the middle of the seventeenth century, gave one of the earliest and best accounts of this curious plant, and the following extract is almost a literal translation from his work.

"On the western side of the Volga there is an elevated salt plain of vast extent, but wholly uncultivated and uninhabited. On this plain, which furnishes all the neighbouring countries with salt, grows the *Boranez* or *Bornitsch*. This wonderful plant has the shape and appearance of a lamb, with feet, head, and tail distinctly formed. Boranez, in the language of Muscovy, signifies a little lamb, [Kæmpfer says that the sheep of the country are called by the people dwelling on the borders of the Caspian Sea, Borannek;] and a similar name is given to this fern. Its skin (continues Struys) is covered with a very white down, as soft as silk. The Tartars and Muscovites esteem it highly, and preserve it with great care in their houses, where I have seen many such lambs. The sailor who gave me one of these precious plants, found it in a wood, and had its skin made into an under-waistcoat. I learned at Astracan, from those who were best acquainted with the subject, that the lamb grows upon a stalk about three feet high; that the part by which it is sustained is a kind of navel, and that it turns itself round, and bends downwards to the herbage which serves for its food. They also said that it dries up, and pines away, when the grass fails. To this I objected, that the langour and occasional withering might be natural to it, as plants are accustomed to fade at certain times. To this they replied, that they had also once thought so, but that numerous experiments proved the contrary to be the fact; such as cutting away, or by other means corrupting or destroying the grass all around it; after which, they assured me, that it fell into a languishing state, and decayed insensibly. These persons also added, that the wolves are very fond of these vegetable lambs, and that they devour them with avidity, because they resemble in taste the animals

whose name they bear; and that, in fact, they have *bones*, blood, and flesh; and hence they are called zoophytes, *i. e.* plant-animals. Many other things I was likewise told, which might however appear scarcely probable to such as have not seen them." (*Struys' Travels*, vol. ii. pp. 28—31.)

(884.) This wonderful tale of Struys, like many other similar stories, although very much perverted, is based on truth. The rhizoma of the *Aspidium Baromez* does present, when the fronds are removed, a rude resemblance in its shape to the figure of an animal, as shewn by the sketch in § 5. It is covered by a soft downy substance, which may be compared to a silky fleece, but from which no under-waistcoat could be made. This fleece is of a reddish-brown colour, and not white. Like the stems of other ferns, the inner parts are soft and pulpy; and it so happens that they have something of a flesh colour, and that the sap is of a rich red hue, resembling blood. From these materials the fable has been composed; and from far less truth much more wonderful histories have sprung. Ferns often grow in barren soils; and, as these vegetable lambs are found on the salt plains, it is not improbable that in such situations they are often seen without grass in their vicinity: but that the herbage is consumed by the fern, or the plants devoured instead of lambs by wolves, although speculations which the wonder-seeking traveller might be tempted to indulge in, it need not be said are ornamental additions, introduced to suit the taste of the narrator, and to pander to that love of the marvellous which prevailed in the age in which he lived.

(885.) The Baromez possesses astringent properties, which are common to all ferns, in a somewhat greater degree than many other species. Hence it was formerly much in repute as a styptic, and both its flesh and fleece were used to restrain immoderate sanguineous fluxes: it is now seldom, if ever, used. Fresh plants are often brought to the markets at Macao, but none have ever yet reached this country alive.

The *Aspidia*, or shield ferns, have been so named from the resemblance their indusia bear to little bucklers (*ασπιδιον*.) *Aspidium fragrans* has been employed as a substitute for tea; and Dr. Buchanan states that the roots of *Nephrodium esculentum*, one of the species in a subgenus of *Aspidium*, are eaten in Nipal.

(886.) *Pteris*, the name given by the Greeks to the leafy ferns in general, on account of their winged or feathery appearance, although now restrained to a single genus, still includes, according to Sprengel's catalogue, 119 known species. Of these but one, the *P. aquilina*, is indigenous to Britain. This, the common eagle brake, is well known as forming excellent cover for game: it abounds on all our heaths and commons, and is the favourite haunt of deer. From its constant profusion in every part of the country, it is not improbably the especial *Fearn* of our Saxon ancestors, from which so many places, as *Fearn*ham or Farnham, Farnhurst, Farnborough, Farnworth, Farningham, &c. have been

named. The fronds are used as litter in the farm-yard and stable; and, in the north of England, cottages are often thatched with it. It is eaten, though sparingly, by cattle; but in the Canary Islands the roots are, according to Humboldt, employed by the inhabitants of Palma and Gomera for food. He says, These poor people grind it to powder, and mix it with a small quantity of barley-meal. This composition, when boiled, is called *gofio;* and the use of so homely an aliment is, as he continues, a proof of the extreme penury of the lower orders in these places. The astringency of the plant must render it a very unpalatable food; for it is so great, that it has been recommended for dressing and preparing kid and chamois leather; and, like the *Aspidium Filix mas*, it has been also used as a vermifuge. A bed made of the plants in a fresh and green state is considered by the country people a sovereign remedy for rickets. The fronds form the best packing for apples which are to be kept, not imparting any unpleasant flavour, and preserving the fruit longer than other means. The ashes, from the alkali they contain, are used in the manufacture of soap and glass. Both Pteris aquilina and Aspidium Filix mas have been employed in brewing; and, from the analysis of the latter which has been made by Morin, it is probable that they would form one of the best substitutes for hops, as they contain both gallic acid and tannin, which are absent from most of the other bitter plants which have been proposed as surrogates, and failed, from being unable to precipitate the glutinous mucilage which renders unhopped beer so liable to turn sour.

Pteris esculenta, a native of the southern hemisphere, is said by Forster to be employed by the inhabitants of the Society Isles as an article of diet: but he says the roots are fibrous, and contain very little nutritious matter.

(887.) The *Asplenia* [§ 68, fig. B,] were formerly considered powerful remedies in diseases of the spleen, and even to be able, if used in excess, to annihilate that viscus; and hence the generic name (α σπλην:) they are, however, simply bitter and slightly tonic. The fine fronds of *Asplenium lucidum* are regarded in some of the Polynesian isles as emblems of sorrow, being carried by the mourners in their funeral processions.

(888.) The genus *Adiantum*, so called from (αδιαντος, *dry*,) because, says Pliny, in vain you plunge it in water, you cannot wet it, contains several very delicate and beautiful species: amongst these is the *Maiden's-hair*, or *A. capillus veneris*, that is used to

flavour the well-known syrup *Capillaire.* Both this plant and *A. pedatum* are astringent, and have been recommended in pectoral disorders. Dr. Ainslie says, a strong decoction of the latter is a certain emetic, and that A. melanococcum is reputed in India to be a tonic.

(889.) *Davallia canariensis* is a curious fern, and well deserving notice. It is commonly called the *hare's-foot*, from the very great resemblance of the rhizoma or stock to the foot of the animal whose name it bears.

(890.) *Cyathea* is also an interesting genus, from containing several arboreous species, [§ 6, 852.] C. medullaris, (the *Polypodium* medullare of Forster,) which grows in New Zealand, and is called by the natives *Mamagu*, is there esteemed as an article of food. The New Zealanders bake the roots and the lower parts of the stem, which are soft and pulpy, and have a pleasant smell and taste; so that the medulla of this fern, which abounds in a reddish glutinous juice, is nearly as good as sago.

(891.) POLYPODIACEÆ. *Polypodium*, and its allies, Acrostichum, Grammites, Ceterach, Gleichenia, Mertensia, Platyzoma, &c. are associated to form the type Polypodiaceæ, which is distinguished from the other annulate ferns by the absence of the indusium, the ringed conceptacles being uncovered, [§ 874, fig. B, *d*.]

(892.) *Polypodium vulgare*, the common wall-fern, or Polypody of the oak, has long been famed for its expectorant powers. It is the 'rheum purging polypody' of Shakspeare. The root is sweetish, and, when powdered, has been employed as an external absorbent, and also as a covering for pills; but, excepting in domestic medicine, it is now very seldom used. Like the Pteris, it is burned, for the sake of the potash procured from its ashes, which is used in the manufacture of glass. P. calaguala, the root of which has an oily disagreeable taste, is said to be a sudorific, and enjoys in America the reputation of being anti-rheumatic. *P. crassifolium* is also used for similar purposes; and both are spoken of as excellent alteratives. The fronds of *Polypodium phymatodes*, like those of various other ferns, are aromatic, and by the natives of the Sandwich Isles they are used, as well as the fragrant Angiopteris, to perfume cocoa-nut oil. The *Ceterach officinarum*, which is the *Chetherak* of the Persian physicians, has been recommended in jaundice: and various other ferns both have been, and might be, applied to various other useful purposes; but as illustrations of the type, the foregoing will suffice.

(893.) The *Polypodiaceæ*, *Aspidiaceæ*, and *Onocleaceæ*, which differ, in the presence or absence of indusia, agree in all having annulate conceptacles, and hence they are associated in the section *Polypodinæ*, or annulate ferns: and, although thus differing from the exannulate types *Osmundaceæ* and *Ophioglopaceæ*, included in the section *Osmundinæ*, they accord with them in their *dorsiferous foliaceous fronds*, and in their fruit being uniform. They hence, collectively, form the order *Pteridales*, sometimes called Filices or *Filices veræ;* but, as these are no more truly ferns than the other orders, Pteridales, from *Pteris*, the original Greek name for this group in general, is here preferred as the common title.

EQUISETALES.

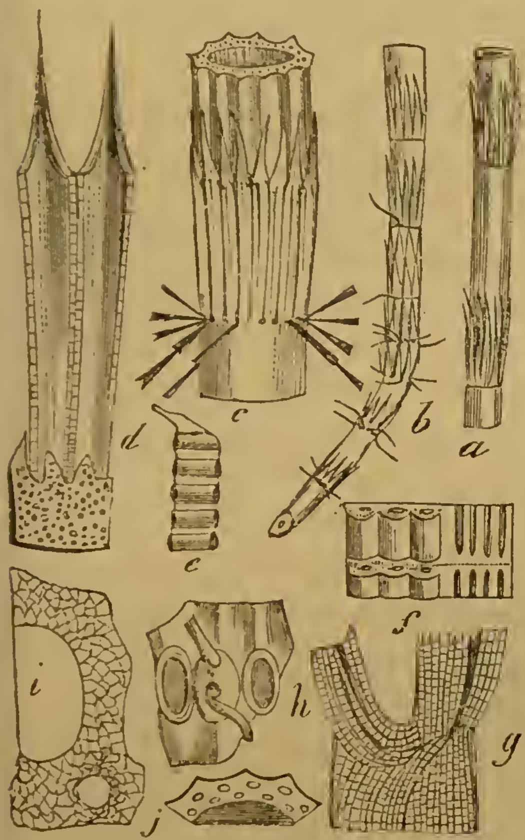
(894.) Beautiful as are the (*Equiseta* or) *jointed-ferns*, which now exist, they have none of that majesty of port which characterized their predecessors of the ancient world; nor are there any arboreous species of this order known to have escaped extermination, as the leafy tree-ferns of southern latitudes have done: the only records that we possess of their antediluvian existence are derived from the gigantic remains that are continually found, by geologists, embedded in various strata.

(895.) Like the more humble of the leaf-ferns, the true stem or stipes of the jointed ferns is situated beneath the surface of the ground, and sends up at intervals its branches or *stipitellæ:* the structure of the stipes differs not greatly from the subterranean stipes of other ferns, but the structure of the stipitellæ or branches that rise above the surface are different in the extreme. They are destitute of any foliaceous expansions, either in their primary or subordinate divisions: they are jointed or articulated at regular intervals, the joints or *nodi* being solid, the spaces between them, (the internodia or internodial spaces,) hollow. At first they contain internally a delicate cellular tissue, but this becomes obsolete during the growth of the plant, leaving a cavity that extends from joint to joint.

(896.) The stipitellæ are frequently quite simple, the nodes being merely surrounded by an annular membrane; at others, from each knot there spring whorls of secondary branches with short bristly processes, which may be considered as the representatives of leaves. The cuticle, which covers the whole of the stipitellæ, is perforated by many stomata, which are situated in the grooves or

channels that traverse them from end to end. A transverse section of these stipitellæ discovers the large central cavity and two circular rows of smaller channels, traversing the vascular parietes of the larger cavity, [fig. *a*, *c*.] The general substance of these plants consists of numerous cells, more or less elongated, accom-

Equisetum fluviatile.



(*a*, *b*) Sections of the stipitellæ shewing the jointed structure, the whorled adventitious rootlets, and the circular sheaths.

(*c*) Enlarged section, shewing the central hollow cylinder and the ring of lacunæ, also the sheath, and the small leaf-like projection of which it is formed, with the origin of the whorled branches in an infra-axillary position.

(*d*) Portion of the vagina enlarged, to shew its structure.

(*e*) The annulate vessels, that surround the lacunæ, shewn by one of the lacunæ being opened.

(*f*) Sections at a joint, shewing the interruption of the lacunæ at each articulation.

(*g*) Longitudinal section through a joint, passing through one of the large lacunæ.

(*h*) Exsertion of the roots from a tubercle at the joint.

(*i*) Transverse section through the internodium, shewing the large external and small internal lacunæ with the cellular structure.

(*j*) Section through an internodium, shewing the concentric large and small lacunæ.

panied and intermingled with false tracheæ or annulate tubes. Their cuticle is regularly and beautifully decked on its internal surface with innumerable minute pieces of flint, arranged in lines and other forms, often not the one five-hundreth of an inch in diameter; and yet so closely set, that in some cases the whole of the vegetable matter has been removed, the silix alone remaining, and still the plant retained its form.

(897.) The fructification of these plants is collected into spikes at the ends of their fronds, [§ 68, D] many of which are barren; the fertile ones exhibit numerous thecæ, which are wedge-shaped and covered by corneous indusia, which, however, are better considered as scales to which the thecæ are attached. The thecæ, which are one-valved, burst lengthwise, and discover within them numerous small green bodies or granules, (called sporules by some,) which have each four elastic filaments springing from the base.

When dry these filaments are curled up, but when moist they expand, and it is probably by this expansion that the thecæ are burst open. Each of these granules, with its filaments, may be considered as a rudimentary flower, the granule being a naked ovulum, (according to Brongniart,) and the four filaments, which have swollen apices, rudimentary anthers, with the pollen which should fertilize the ovule ; but still smaller grains are likewise to be found, which others consider the true pollen, and the filaments as the threads of rudimentary anthers.

(898.) The granules of these plants have by some persons been supposed to be true seeds, and to possess the cotyledon or seed-lobe, which is developed as a characteristic of the following class. But, when these granules are watched during germination, the supposed cotyledon appears to be rather the result of growth, like the pseudo-cotyledons of the other ferns and mosses, than an organ pre-existing in the granule. The accompanying sketches by Vaucher shew the gradual development of the granule, with its

Germination of Equisetum.

(*a*, *b*) Granules swelling and beginning to protrude the roots. (*c*) The root formed, and the supposed cotyledons developed. (*d*) Same parts farther advanced. (*e*) A young plant with its first whorl of branches. (*f*) Ditto stem beginning to be formed. (*g*) Last figure, natural size.

primordial and secondary expansions, which, although forerunners, of cotyledons, are not really such.

(899.) A very considerable analogy will be found to subsist between these plants, especially in their organs of fructification, with an order to be subsequently described, viz. the Pineales, along with which the cycases are arranged, and in which the ovules are

naked, the seeds collected into cones and covered by scales; just as is here observed.

(900.) Only a single genus, Equisetum, is known, which therefore stands alone in the type Equisetaceæ, which is the only one in the section Equisetinæ. By some these ferns have been called *Gonyopterides*, on account of the jointed stem so very characteristic of the order.

(901.) The leafless ferns or Equiseta, are not often used in medicine, although, as diuretics, they have been much extolled. Few animals feed on them, and they are said to be injurious to pigs; while horses, sheep, and asses, eat them with impunity. Linnæus affirms that reindeer, who refuse to eat hay, will eat the E. fluviatile, and that it is cut as fodder for kine, but that it is not so acceptable to horses. Several species of *Equisetum*, particularly *arvense*, *sylvaticum*, and *variegatum*, often form tubercles on the subterranean stems, like those of potatoes; and as, according to Haller, the E. fluviatile was eaten by the common people among the Romans, it was probably these tubercles, which are replete with starch, that were the parts selected as food: and hence, in all likelihood, this plant was the CHARA mentioned by Cæsar [§ 795,] for it abounds on the banks of lakes and rivers, and in other swampy places. They contain much flint, as already mentioned, in a very minute state of division, and which is spread over their cuticle, and thus renders them admirable natural files. Hence botanists sometimes use them to smooth their nails; and cabinet-makers and workers in marble employ large quantities for polishing their finer works. One species especially, viz. the E. hyemale or shave-grass, is imported from Holland for these purposes, under the name of *Dutch-rush*. When plates and other utensils for culinary and table service were made of pewter, the Dutch-rushes were in very great request in the scullery; the whitesmiths use them now, and the superior polish they give to their works depends upon the peculiar fitness of the exceedingly fine flint for such purpose. The milk-maids in the dairy counties still use the shave-grass to clean their pails.

(902.) The Equisetales or shave-grasses, (the Prêles of the French,) are leafless, flowerless, tubivascular plants, with sheathed, hollow, jointed stems, uniform fructification collected in terminal spikes or cones; the conceptacles enclosed by scales, and the sporules surrounded by elastic filaments; vernation straight.

(903.) These three orders, *Equisetales* (or shave-grasses), *Pteridales* (or brakes), and *Selaginales* (or moss-ferns), constitute, collectively, the class FILICES or FERNS: the first of the region to which it belongs; but in which, notwithstanding the great advance in organization and vast development of the vegetative system, the organs of fructification are still so slightly evolved, and so obscure, as to have in general caused them to be placed lower in the scale than their structure would allow. Yet, although with propriety they are denominated flowerless plants, they cannot, without violence, be severed from the other tubivascular classes.

(904.) The *Equisetales*, *Pteridales*, and *Selaginales*, which are respectively distinguished by being, 1st, leafless and articulate, 2dly, foliaceous and dorsiferous, and 3dly, leafy, inarticulate, and not dorsiferous, are associated by their tubivascular structure and destitution of flowers and seeds, to form, collectively, the class Filices or Ferns; which is thus easily distinguished from the two following classes, both of which, although, like the ferns, tubivascular, contain none but flowering and seed-bearing plants.

(905.) The annexed table affords a summary conspectus of the whole of the orders, sections, and types, into which the class has been distributed.

Class.	Orders.	Sections.	Types.
FILICES or FERNS. (904)	Equisetales (902)	Equisetinæ (900)	*Equisetaceæ* (900)
	Pteridales or Filicales (893)	Polypodinæ (871)	*Polypodiaceæ* (891) *Aspidiaceæ* (877) *Gleicheniaceæ* (872)
		Osmundinæ (869)	*Osmundaceæ* (866) *Ophioglossaceæ* (863)
	Selaginales (849)	Lycopodinæ (839)	*Lycopodiaceæ* (843) *Isoetaceæ* (840)
		Marsilinæ (846)	*Marsileaceæ* (847) *Salviniaceæ.* (848)

GEOGRAPHICAL DISTRIBUTION OF THE FILICES.

(906.) The three orders into which the ferns have been systematically distinguished enjoy a nearly equal range of geographical distribution; and, although there are some features peculiar to each, the grand characteristics are common to them all.

(907.) In their distribution, the ferns follow a law exactly the reverse of that which regulated the two previous classes, for they abound within the tropics, and decrease both in size and number towards the poles; instead of being most numerous in the cold and temperate regions, and diminishing towards the equator, as was found to be the case with the mosses and the fungi.

(908.) The foliose, frondose, and leafless ferns, although, as natural orders, of

equal rank, differ remarkably in their extent; the one including about 2000, while both the others cannot count 200 existing species between them. According to Sprengel's catalogue, the numbers are, 162 Selaginales, 18 Equiseta, and from 12 to 1500 Pteridales: which last, according to Brongniart, should be increased to at least 2000.

(909.) The frondose ferns will therefore, from their predominance, claim our first and chief consideration; and, as the others are subject to the same general laws, a few words will suffice to explain the special exceptions that occur.

(910.) The following calculation places the first great character in the geographical distribution of the ferns in a very striking point of view. If three zones be supposed to encompass the earth, the central or equatorial zone extending to about 30° or 35° on each side of the equator, and the northern and southern temperate and frigid zones from the 30° or 35° of northern and southern latitude to the poles, there will be found, according to Brongniart, in the northern temperate and frigid zone, only 144 indigenous species, and in the southern temperate and frigid zone 140 species; while the rest of the frondose ferns, amounting to at least 1200, are peculiar to the central or equatorial zone. And not only are the equatorial regions, thus taken in their totality, surprisingly more rich in ferns than the temperate and frigid zones, but if a smaller tract from each were compared, the contrast would be still stronger, for many more species are common to distant countries in warm latitudes than in cold ones.

(911.) It is customary, especially among tubivascular plants, to calculate, not only the absolute number of any given genus or order in any given latitude or country, but also to form a comparative estimate of the proportion it forms of the vegetation of those places, and of its greater or less predominance in such local or general floras.

(912.) The difficulty of ascertaining the number of flowerless cellular plants causes them in general to be excluded from these calculations, which usually refer to the tubivascular plants alone. The known species of flowering plants have been estimated at about 50,000, and the ferns at 2000; the mean relation, therefore, which ferns bear to other tubivascular plants in the vegetation of the earth in general, is as 1 : 25, or, if the foliose ferns alone be taken, as about 1 : 30. The average, however, is liable to excessive variations in different countries, not only as regards their latitude, but also their physical peculiarities, such as the nature of the soil, insular or inland condition, &c.

(913.) Ferns luxuriate in warm, damp, shady situations: where these three conditions are present they are met with in abundance. Heat, without shade and moisture, is unfavorable to their increase, and therefore, although numerous in Jamaica and the other West India Islands, they are rare in the wide valleys of the Andes.

(914.) In different parts of Europe the relation varies from $\frac{1}{35}$ to $\frac{1}{80}$, the average being on the whole, in the temperate zone, about $\frac{1}{70}$, while within the tropics it is $\frac{1}{20}$. In insular situations the proportion rises much higher, ferns being to other tubivascular plants in Jamaica $\frac{1}{9}$, in New Zealand $\frac{1}{6}$; in the Sandwich Islands and in Otaheite it is $\frac{1}{4}$, which appears to be the general average in Polynesia; and in some small mountainous islets, as Norfolk and Ascension Islands, and St. Helena, the proportion reaches even to $\frac{1}{3}$.

(915.) In continental situations, although in the same latitudes, their propor-

tion is much less: thus, according to Humboldt, in the most favorable intertropical continental situations, the proportion is not greater than $\frac{1}{26}$ or $\frac{1}{20}$, and in equinoctial America it is $\frac{1}{36}$. In Western Africa and India it is $\frac{1}{26}$, in New Holland $\frac{1}{38}$, in France $\frac{1}{63}$, in Portugal $\frac{1}{116}$, and in the Greek Archipelago $\frac{1}{227}$. The decrease towards either pole is thus very evident; but further northwards, from the diminution of flowering plants, the proportion again rises. Thus, in France it is $\frac{1}{73}$, in Germany $\frac{1}{71}$, in Scotland $\frac{1}{31}$, in Sweden $\frac{1}{35}$, in Iceland $\frac{1}{18}$, in Greenland $\frac{1}{10}$, and at the North Cape $\frac{1}{7}$. Ferns are very rare on Mount Atlas, almost wholly absent from Egypt, and in Melville Island there are none.

(916.) But the number of ferns, whether absolute or relative, is not the only point in which they differ in different regions. The form and structure of these plants bear some relation to the places in which they grow. Thus certain genera, and even certain tribes, are entirely or almost entirely confined to certain determined climates; for example, the temperate and frigid zones scarcely produce any other ferns than the *Polypodiaceæ*, *Aspidiaceæ*, and a few *Ophioglossaceæ*. Hymenophyllum tunbridgense, and two or three species of *Trichomanes*, are the only representatives of the *Hymenophyllidæ*; and the other types, and even numerous genera and species of these, are wholly absent.

(917.) The magnitude of these ferns affords another remarkable evidence of the effects of climate. In the cold and temperate regions they are herbaceous, rarely even shrubby plants; but in warmer latitudes they become frutescent and arboreous. It has been sometimes thought that true ferns are confined to the equatorial zone; but Mertens discovered them fifty feet in height in the Isles of Bonin, near Japan, in the 28° north latitude; and in the southern hemisphere they occasionally extend as far as the 45th degree. Still the torrid zone is the especial region of arboreous ferns, and there, only, are they found in abundance. Beyond the twentieth parallels they are scarce, for, in the southern hemisphere, without the tropics, in New Holland and New Zealand, as yet there have been discovered only two.

(918.) Such are the general statistics of the *Pteridales* or *frondose ferns*, of which those of the Selaginales and Equisetales are very nearly counterparts. For, notwithstanding the outward resemblance the former bear to mosses, they follow geographically the general distribution of other ferns, which is the very reverse of that affected by the plants to which in external appearance they are allied. And thus the at present existing humble species shew a physical as well as a structural agreement with the Pteridales, which becomes still further corroborated when the gigantic Lycopodia, now extinct, are compared with the arboreous ferns that have escaped the wreck of time.

(919.) Of the two sections included in this order (*Selaginales*), the Marsilinæ, which are all aquatic, are found in marshes, rivers, lakes, and other inundated places in various parts of Europe, Asia, Australia, Africa, and America. Like other water-plants, they are less affected by latitude than by locality; but they seem to prefer the temperate zones, and to be less common towards the poles and within the tropics.

(920.) The *Lycopodinæ* extend further, both north and south, than the *Marsilinæ*, being, like the frondose ferns, most prevalent in hot damp situations, particularly in small tropical islands. In the higher latitudes they greatly and gradually decrease, but in the northern parts of England and in Scotland some of

the Lycopodia are common; and even in Lapland extensive tracts are profusely covered with *Lycopodium alpinum*, and *Selaginoides*. Isoetes is found in the still waters of various countries in every quarter of the globe.

(921.) The *Equisetales* are found, like both the foliose and frondose ferns, in every latitude, stretching from the equator to the poles. They are very numerous in the tropical parts of America and Asia; at the Cape of Good Hope they abound, and they continue common in the temperate zones, but become rare towards the polar circles. In New Holland there are none, or, at least, in that country they are as yet unknown.

(922.) Topographically considered, their station is chiefly in marshes, where they form as it were forests, resembling tropical groves of palms in miniature. As they become rare in the frigid zone, so they are seldom found at any great height on mountain-ranges, and are wholly absent from the elevated regions of the Alps; for, according to Vaucher, the E. sylvaticum, which is found at a greater altitude than any other species, never reaches higher than from 300 to 400 toises, [=1800 to 2400 feet.]

(923.) The difference in size in the different species of this genus, according to the climates in which they grow, is another fact well worthy of attention. The two smallest Equiseta known, are the *E. scirpiöides* and *E. reptans*, which are indigenous, the one to Canada, and the other to Lapland; while the largest species, on the contrary, is our *E. giganteum*, that attains five feet or more in height, and which is found in the Antilles.

(924.) The application of these facts is obvious; for a link is thus laid hold of which will connect our modern puny plants with those majestic species which flourished to excess in some of the earlier epochs of this globe. Such facts are therefore curious and important; they possess a value beyond their simple truth; for the knowledge now accumulated of the geographical and topographical distribution of these especially, as well as of other plants, when collated with the geological investigations which at this moment are being carried on with unprecedented ardour, and to an almost incredible extent, cannot fail, as Brongniart has well observed, to throw much light upon the ancient history of the world.

GEOLOGICAL DISTRIBUTION OF THE FILICES, OR FERNS.

(925.) In the various strata of which the crust of the earth is formed, the fossil remains of numerous ferns are found. These, like the vestiges of other plants, occur in very different absolute numbers, and in very different relative proportions, in the successive series of beds which are believed to have been deposited during different geological epochs. Do the geological positions and the structural peculiarities of the primæval ferns accord with the geographical distribution and climatorial modifications of the, at present, existing species? Furthermore, what light, if any, does the collation of facts, derived from both these sources, throw upon the history of the dark ages of the world?

(926.) Some traces of fossil ferns are found in almost every series of strata from the later transition to the beds above the chalk. But it was the coal era in which they were predominant, not only in size, but also in absolute number, and in relative proportion.

(927.) The economical value of coal as fuel has rendered the flora of its epoch more accessible and more familiar to us than that of most others, save our

own. This is evident from the fact, that of the 500 fossil plants now known, upwards of 250 belong to the coal measures; and thus, all the other strata put together produce less than half of the total sum.

(928.) The former relative predominance of ferns may likewise be shewn by a similar calculation. Thus, of 472 fossil tubivascular species enumerated in Brongniart's Prodromus, 226 are decidedly ferns; he reckons them at 290, but 64 are doubtful: and it is more than probable that, hereafter, they will be generally admitted to belong to the subsequent classes, which would otherwise seem to have had only 182 representatives in these early ages.

(929.) The relative predominance of ferns seems to have been greater in the coal era than at any other period. From present data they appear to have then formed more than three fifths of the vegetation of the earth: for, of the 258 tubivascular plants included in the coal flora, 158 are decidedly ferns, while at the utmost only 98 flowering species have been hitherto discovered; and 60 of these, including the Sagillariæ, are considered by Brongniart to be ferns, which computation would increase the former number to 218, and reduce the latter to 38.

(930.) Only three fossil ferns have hitherto been found in the beds below the coal, which Brongniart reckons as part of the transition series; although it is doubtful whether they should not rather be classed with the secondary rocks, and associated with the coal strata. Two of these are representatives of the modern order Equisetales, [§ 935, fig. I, K,] the other of the frondose ferns, [§ 935, C.]

(931.) The earliest traces of any plants allied to the *Selaginales* is in the coal formation; and there, with other ferns, they are most abundant. The excessive profusion in which fossil plants occur in the shale accompanying the coal seams. though well known to all who examine the collieries, is scarcely conceivable by such as are not familiar with the subject.

(932.) In the limestone, above the coal, not any vestiges of these plants have hitherto been seen, and in the new red sandstone they are scarce, only six species of frondose ferns and three calamites having been observed. In the Lias and Oolitic series their relative proportion to other tubivascular plants becomes less and less; and the gigantic Lycopodiaceæ are wholly absent. In the beds above the chalk, vestiges of ferns are comparatively very rare, and their numerical relation to other plants is nearly that which the existing species hold in temperate regions at the present time.

(933.) Another problem connected with this inquiry springs from the foregoing generalizations, viz. Are the ferns, the remains of which are found in different strata, identical with species now existing; or in what degree are they related to their successors?

(934.) Some of the fossil ferns are so similar to those now growing on the surface of the earth, that no doubt is entertained they are generically the same; this is the case especially with the Equiseta, many of the fossil remains of which being considered only specifically distinct, are included in the same genus with the existing species, and are called by one common generic name.

(935.) *Equisetum brachyodon*, [fig. D, E,] which Brongniart considers as one of the fossils bearing the nearest resemblance to our modern existing species, is found in the tertiary series; *E. Meriani*, [F,] and *E. columnare*, which differ more considerably from the present forms, belong, one to the variegated marls of the Lias; and the other to the oolite below the Lias. The latter was an arboreous

Equisetum. *E. infundibuliforme,* [G, H,] which deviates still more from the present normal appearance of these plants, is found in the coal strata; and Brongniart

A. Lepidodendron selaginöides. (*Lindley* and *Hutton,* 12.) B. Lycopodites falcatus, reduced. (*L.* and *H.* 61.) C. Ditto, portion magnified. D, E. Equisetum brachyodon. (*Brong.* 12.) F. Equisetum Meriani. G, H. Equisetum infundibuliforme. I, K. Calamites radiatus.

asks whether it may not be a branch of a Calamite, a fossil genus which, though absent from the recent strata, is common in the coal formation.

(936.) The majority of the fossils allied to this order of the ferns are however so different from the modern genus Equisetum, that they are formed into a distinct group called Calamites, a name derived from their once supposed resemblance to a reed or cane; and, although now associated with the Equiseta, the justice of this arrangement is not unquestionable.

(937.) The *Calamites* appear to have been plants of very considerable magnitude, for fragments are found many feet in length, and some of the stems, as that of *C. pachyderma,* measure five inches, and others, as those of *C. gigas,* even a foot in diameter. It is not, however, their great size which renders it doubtful whether they should be associated with the Equisetales, for the Equiseta themselves gradually assume in the older strata an arboreous form, but the apparent separation of the stem into layers, which structure is foreign to this class and the peculiar characteristic of others. *C. radiatus,* [I, K,] from the transition beds, Brongniart thinks a corroboration of the present arrangement; the radii, [§ 934, fig. K,] or whorled processes at the joints, being by him believed to be equivalent to the vagina of the Equiseta. Another view has been, however, taken by Lindley and Hutton, who would regard the radii as verticillate leaves.

(938.) From the mutilated condition in which fossil plants are ordinarily found,

it is always difficult, and often impossible, to recognize those characters which distinguish the genera and species of the existing flora. With regard to the Equisetales, the smallness of the order, and the great peculiarity of the structure of those plants, reduced the difficulty; but in the large order, Pteridales, the sections, types, and genera of which are founded upon minute and very destructible organs, the difficulty is severely felt.

(939.) Thus, of the numerous fossil frondose ferns, not one has been absolutely recognized as specifically appertaining to any existing genus, although it can frequently be determined to which type or section they belong. Thus, *Pecopteris heterophylla* so much resembles a *Pteris*, especially *P. caudata*, that there can be no doubt that it belongs to the same type, if not to the same genus; and *P. polypodioides* is so like the common wall-fern, that, as Lindley and Hutton observe, it is doubtful "whether, if a recent fern were discovered, with so much similarity, and so little discrepancy, it would be considered more than a variety of Polypodium vulgare."

In several instances even the fructification of the ferns is well preserved, as seen in *Neuropteris flexuosa*, [A, B,] and in *Sphenopteris rigida*, [D, E.] And,

A. Neuropteris flexuosa in fruit, (65.) B. Smaller portion of the same magnified, to shew the venation and disposition of the sori. C. Cyclopteris flabellata, (61.) D. Sphenopteris rigida. E. A pinnule of the same enlarged, to shew the fructification, (53, *Brong.*) F. Caulopteris primæva. (*Lind.* and *Hutt.* 42.)

as Brongniart observes, there are several such remarkable genera in this order, such as *Osmunda*, *Aneimia*, *Lygodium*, *Schizea*, &c. that if vestiges of their fructification remained, they could not fail to be recognized; *Botrychium* and

Ophioglossum also could scarcely escape detection; and the singular fronds of *Schizea* and *Gleichenia* would at once distinguish them, even without the fructification. But as none of these have been discovered in a fossil state, it is probable that the *Osmundaceæ*, the *Ophioglossaceæ*, and the *Gleicheniaceæ*, were not included in the flora of the ancient world; and that, during the epoch of the coal formation, the *Polypodiaceæ* and *Aspidiaceæ* were the only types of frondose ferns existing: for *Pæniopteris*, which approaches by the distribution of its nervures to the *Marattidæ*, belongs to the later beds of the Lias.

(940.) The fossil genera *Neuropteris*, [§ 939, fig. A, B,] *Pecopteris*, *Odontopteris*, and *Sphenopteris*, § 939, D, E,] contain the most numerous species of the coal epoch, and some of them are met with in profusion in almost every carboniferous shale; they are therefore cited as familiar examples: *Cyclopteris flabellata*, [§ 939, C,] is the only species that occurs in the beds below the coal.

(941.) The specimen of *Caulopteris primæva*, [§ 939, fig. F,] found in the Radstock coal-mines, near Bath, and now in the possession of the Geological Society, is beyond doubt the remains of a tree-fern, and thus affords decided evidence that such plants formed part of the flora of the coal epoch, which, from their present localities, might have been supposed. It is therefore, at this time, a specimen of peculiar interest and importance; since recent investigations have rendered it probable that many of the fossil stems once thought to be the remains of arboreous ferns, belonged to plants of a different class.

(942.) Some of the fossil Selaginales are very similar to the *Lycopodia* of the present day, such as *Lycopodites falcatus*, which is an oolitic fossil, [§ 935, fig. B, C.] But the most numerous and remarkable Lycopodial remains are those gigantic fossils called *Lepidodendra*, [§ 935, A,] and *Ulodendra*, some fragments of which measure near fifty feet in length. These enormous moss-ferns, with their supposed fruits, called *Lepidostrobi*, with several species of *Lepidophyllum* and *Selaginites*, are common in the coal formation, and are supposed to have flourished in this epoch only, as they are found exclusively in the coal series. Their remains are wanting in all the superior strata, and it is only some few species of *Lycopodites* which more or less approach the Lycopodia of the present day that are found in the more recent beds.

(943.) The *Sphenophylla*, which Brongniart considered as fossil *Marsileaceæ*, and the *Stigmariæ* which he esteemed gigantic fossil *Isoetes*, a kind of monstrous aquatic quill-ferns, analogous to the immense terrestrial *Lepidodendra*, can no longer be associated with fossil-ferns, their affinities baving now been satisfactorily traced to different orders.

(944.) Such are the principal facts hitherto discovered relating to the geological distribution of the ferns, and from them the following generalizations may be safely drawn. *First*, that in the oldest strata, in which land-plants occur, ferns are met with in the greatest abundance. *Secondly*, that tbeir absolute numbers and relative proportions become wonderfully diminished in the superior formations, until, in the later series, they are comparatively scarce. *Thirdly*, that not only is their numerical strength astonishingly lessened, but that they are still more remarkably reduced in size.

What external physical influences can have wrought these changes? The effects are obvious, shall the cause for ever be unknown?

(945.) The study of fossil plants being as yet but an infant branch of botany,

all theoretical views are indulged with fear, and even simple generalizations are advanced with diffidence. And it is right that it should be so; for little more than 500 extinct species have been hitherto discovered, while there are proofs enough vegetation was formerly much more luxuriant than now, and that opportunities alone are wanted to extend the catalogues. The materials are abundant.

(946.) But although future researches may considerably affect conclusions founded upon present data, the variations will be rather in degree, than kind; for the extensive mining operations which for a long time have been carried on in this, as well as in foreign countries, have as it were accidentally revealed so many facts, that the chief inferences drawn therefrom, corroborated as they are in other ways, especially by phyto-geographical researches, can scarcely be set on side.

(947.) It will be remembered that the chief statistical and topographical generalizations which have been established by the researches of botanical geographers, are, *first*, that ferns are small in size, and few in number, both absolutely and relatively, in the temperate and frigid zones, if the vegetation of these extra-tropical latitudes be compared with that of the equatorial regions; in which their magnitude is greater, and their number more. *Secondly*, that small islands and low swampy tracts are more favorable to their development than extensive continents and lofty hills. And, *thirdly*, that if the atmosphere be moist, they will luxuriate amidst barren sand, or upon rocks almost destitute of vegetable mould; throwing out their foliaceous fronds, and even elevating their noble arboreous stems from the nearly naked stone, to which they are indissolubly bound by their clasping roots: when unsteadied by any depth of soil, their trunks can be shaken by the feeble force of the human hand.

(948.) The coincidence between these geographical and geological generalizations is obvious; and their tendency to corroborate the views suggested by similar inquiries, into the habits and distribution of extinct and existing algæ, no less remarkable than important: for thus, some hints, which at first seem vague, and views that appear chimerical, become, as they are gradually unfolded, more and more plausible; and if true, their truth can alone be finally established by the concurrent testimony afforded by analogous investigations into the physical conditions of other classes both of plants and animals.

(949.) Of the Equiseta that are found in a fossil state, *E. brachyodon* the most resembles our modern plants; but its resemblance is rather to our tropical than extra-tropical species: and several of the other fossil Equiseta exceed in size the largest indigenous in our torrid zone many times more than our largest equatorial exceed our smallest Lapland and arctic species. The same holds true with regard to the *Selaginales*; and in numerical proportion, if not indisputably in size, with regard to the frondose ferns. For, in relative numerical strength, the ferns in the coal era exceeded their representatives in the most favorable parts of our torrid zone more than equatorial ferns in the present day exceed those of the temperate and northern regions.

(950.) Now, as existing ferns are the largest and most numerous in our warmest latitudes and most moist localities, it is probable that, in those geological epochs in which they were much more prevalent and attained a larger size than now, even in the most humid parts of the torrid zone, the atmosphere was more moist and the temperature higher, even in the extra-tropical regions, than it is at present in islands under the equinoctial line.

(951.) As *Tæniopteris*, and other fossil ferns, which are found in the superior trata of our temperate latitudes, although dissimilar to any now existing, bear he greatest resemblance to the *Marattidæ*, which are exclusively tropical plants, rowing in Jamaica and other similar hot localities, the atmospheres of which, rom their insular condition, are necessarily humid, it is highly probable that, in he tertiary epoch, the climate of the now temperate regions resembled that of the orrid zone; that the temperature was at least as high, and the dampness great.

(952.) As the fossil floras of the secondary strata, and especially that of the coal ormation, abound in ferns unlike any that now are known, and as they exhibit n excess those characters of numerical strength and enormous magnitude to which the vegetation of tropical islands affords the nearest approach, although it gives but a very faint conception of them, it is more than probable that the physical conditions now essential to produce arborescent equiseta, and arboreous frondose erns, were then present in a degree as much exceeding that of our intertropical slands, as the relative proportion of ferns, and their size in the coal strata, exceed heir size and number in the hottest and dampest parts of our torrid zone; and, if o, that the globe, in the epochs referred to, had much less land raised above the surface of the waters than at present; that the then highest lands of the vast eastern and western continents were islands in a boundless ocean; that the temperature of the earth was more equable and much higher than at present; that the air was rrespirable, and the atmosphere loaded with vapours.

(953.) The excess of watery surface, which it is demonstrable at one time existed, would very much tend to equalize the temperature of the islands which it is resumed were emerging from the bosom of the deep; and, although the evidence s not as yet complete, the theory of more equable temperature receives some onfirmation from the fact, that the coal floras not only of North America and Europe are for the most part identical, the species being referrible often even to he same genera, but also that, of the few fossil plants brought from the coal strata of Baffin's Bay, New Holland, and Hindoostan, (*i.e.* from the northern, the outhern, and the torrid zones,) the chief are ferns belonging to the same natural roups with those which predominate in the coal formations of central Europe: nd uniformity of vegetation is one strong evidence of uniformity of temperature, s well as of other physical conditions.

(954.) That the atmosphere in this epoch was irrespirable by man, although nerely adventured by Brongniart as a speculation, is not destitute of circumstanial evidence in its favour. The two chief arguments go to prove that the proporion of oxygen was once much smaller, and of carbonic acid much greater, than at resent; and that the former has been increased, and the latter diminished, hrough the agency of plants, and perhaps principally of ferns.

(955.) The first of these propositions is countenanced by the more perfect state of preservation in which the fossil remains of plants are found in the old than in he newer strata; which could not have been the case had external physical circumtances in all these epochs been the same: and as the decomposition of dead plants, nd their transformation into vegetable mould, is due almost entirely to the subraction of a part of their carbon by the oxygen of the air, and as excess of carbonic acid would retard or prevent their decay, it is not improbable that their more erfect preservation in the older strata may be attributable to such a cause; furher evidence of the existence of which will immediately be offered.

(956.) Below the coal series, and the strata immediately subjacent, in which land-plants first appear, no vestiges of mould are found; and yet the vegetation in this epoch was most luxuriant, and most profuse. Heat, as a constant stimulus, combined with moisture, would be a great incentive to inordinate growth: but whence was the solid matter derived which the plants assimilated? whence did they procure the enormous quantities of carbon which, supplied with such unbounded prodigality, successive generations formed into those vast beds of coal that are spread, in interrupted strata of variable thickness, from the arctic to the antarctic pole?

(957.) This is a circumstance which it is difficult to explain; and of the existence of the difficulty no doubt can be entertained, although, as Brongniart observes, it is a point which has hitherto excited far too little attention. "It is evident," continues he, "that the organized beings now in existence, both animals and vegetables, as well as the deposits of combustible fossils, bitumens, &c. of all ages, are composed of a large quantity of charcoal, which, before the existence of the beings that now contain it, and which have deposited it in the various strata, must have existed in nature in some other form, and in such a state, that they were enabled to assimilate it: and as no vestiges of charcoal, in a solid state and an assimilable form, is found below these strata, it is not unreasonable to suppose that the carbon was spread throughout the atmosphere in the form o. carbonic acid; and that it was from this state that vegetables have from the first been labouring to convert it into fitting food for animals.

"It is well known, from the experiments of Saussure, that the proportion of carbonic acid now present in our atmosphere is far from being that which is most favourable to the growth of plants, and that a quantity much greater by two, three, four, or even eight per cent., renders their vegetation more active and vigorous when they are exposed to the influence of the sun. A larger proportion of carbonic acid than now actually exists in our atmosphere ought, therefore, to make plants not only more vigorous in their growth, but also more independent of a soil as yet sterile and charged with little mould, by allowing them to live almost entirely at the expense of the atmosphere." And such is known experimentally to be the case; for many plants, such as the *Grasses*, which derive little nourishment from the atmosphere, greatly exhaust the soil in which they grow; while others, with broad expanded foliage, such as turnips and mangel wurtzel, rather improve than impoverish it.

"This hypothesis of the presence of a large quantity of carbonic acid in the atmosphere at the epoch of the coal formation, without which it is impossible to conceive how any plausible explanation can be given of the origin of all the carbon which now is fixed in a solid form in organized bodies, both fossil and living, coincides perfectly with the well-ascertained fact, that terrestrial plants are of a more ancient date than air-breathing animals, to whom so large a quantity of carbonic acid would have been a deadly poison. Thus, it was not until after successive generations of plants had purified the atmosphere of its excess of carbon, and fixed it in the soil in the state of coal and of other combustible matters, that air-breathing animals, at first reptiles, and afterwards beasts and birds, were enabled to live on the surface on the earth. At this time there was brought about the state of equilibrium between the respiration of plants and that of animals which characterizes the present epoch, and which is perhaps one of the causes of the stability in the forms

of organic living beings; as the variableness of the atmosphere was not improbably one of the secondary causes of their former variability."

(958.) There seems to be a peculiar fitness in the selection of such plants as ferns, which will grow on the bare and barren rocks, and especially in selecting allies of the *Polypodia*, that derive their food chiefly from the atmosphere, to be the chief secondary means by which such great and beneficial works might be performed.

To have substituted grasses would have been useless, when there was no vegetable mould upon which they could subsist themselves, and none of those animals existed that they are required to sustain. Ferns, of which few are eaten by any animals, and which, as may be seen in the case of the common wall-fern, require no rich soil for their support, seem to be, of all other plants, the fittest for the purpose.

(959.) This theory, it is confessed, is in a great measure conjectural, and therefore it has been given nearly in its author's words; it is, however, very plausible, and not wholly gratuitous. It accounts for many things which are otherwise unaccountable; and, being based on established facts, it involves no apparent absurdity. It is a theory, or view, of certain facts; it may be false, but it appears to be borne out by our present knowledge. It was only given as an hypothesis, and it is quoted as nothing more.

Such a state of atmosphere will account for the luxuriant growth of plants without mould or sustaining soil; such a superabundance of carbonic acid well accounts for the better preservation of vegetable remains in the older than in the newer strata; and such a source is the most reasonable that can be conjectured as that from which the immense quantities of carbon could be derived, which, through the medium of vegetables, have been converted into coal.

If the atmosphere in these epochs was thus laden to excess with carbonic acid gas, it would be unfit for the respiration of any terrestrial animals now known; and there is negative proof that none such then existed, as no fossil remains of any have hitherto been found.

(960.) The office of the ferns and the other plants of the coal formation, and the final cause of their predominance in that period, would therefore seem to be that, by their assimilation of the carbon, and liberation of the oxygen with which it was combined, they might purify the atmosphere, and bring it into a condition in which it would become respirable by reptiles, beasts, and man. That such was the primitive condition of the atmosphere, and that it thus was gradually purified by the growth of plants, seems to be not improbable, from the circumstance that reptiles and other cold-blooded animals, which can endure and enjoy an atmosphere that would be fatal to warm-blooded animals and man, are the earliest of which any fossil remains are found. That the atmosphere at first was very greatly loaded with carbonic acid, is probable from reptiles not appearing until after the coal formation; and that it required many successive generations of plants to render it respirable for birds and beasts, is also likely, as it is not until long after that any vestiges of these animals are found.

These were the immediate precursors of the human race, the sovereigns of a world which they underprize, and of which they little know the wonderful structure and the surpassing beauty. It is science which can alone display the greatness of the works of creation; it is science which alone can truly tell how much fashioning this earth required to make it habitable by man.

OUTLINES OF GRAMINOLOGIA.

(961.) The grasses form one of those large and very natural groups of plants which, marked by strongly characteristic features, have been universally associated, and their affinity acknowledged by the learned as well as the simple. Science has here done little more than sanction and describe the boundary which untutored observation previously had traced: in some parts, however, it has been drawn anew and occasionally diverted, in order to render it consistent with itself.

(962.) Some of the grasses have been long celebrated for producing large seeds and very nutritious leaves, which for ages have formed the staple food of domestic animals and man. These have been called the *cereal* or *corn*, and the *pasture* or *fodder grasses*. Others are as remarkable for their destitution of these valuable properties, and are notorious for their meagre seeds and innutritious foliage. Hence they have been called *Carices*, from *careo*, to be absent, or to want. They are the sedges, or reed-grasses, of the farmer.

(963.) *Gramen* was formerly the common name for all the grasses. But, when they were distinguished into two orders, the corn and fodder-grasses were alone called *Gramina*, and the sedges were named *Calamariæ:* a collective term being sought from their several peculiarities of structure. Thus, by some they were denominated *Plantæ glumaceæ* or husk-flowered, and by others *Culmiferæ* or straw-stalked plants. But, as the restricted use of the word *Gramina* has long since fallen into neglect, and now become almost obsolete, the two orders being respectively called *Gramineæ*, and *Cyperöideæ*, or *Cyperaceæ*, by Jussieu, De Candolle, and others, the original Gramina may most advantage-

ously be restored to its former comprehensive signification, and again become the common collective designation of the whole.

(964.) Our English word *grass* is a very ancient one, and exists, with slight modifications, in all the Teutonic dialects; thus, in Anglo-Saxon, we find *Graes* or *Gaers*, in German *Gras*, in Danish *Gräs*, in Swedish *Gras*, and in Icelandic *Gras;* even in Greek there is γρασις, a word of exactly the same meaning, though *ποα*, *ποη*, or *ποιη*, are more commonly used.

Chloa (χλοα), another Greek name for *grass*, has given origin to the adjective χλορος, *grass-green*, whence *Chlorine*, and *Chlorosis*, are derived.

Gramen has been whimsically deduced *à gradiendo*, but seems rather to be connected with germen.

Agrostis, (Ἀγρωςτις from Αγρος, a field,) like the Saxon *ley* or *lea*, denotes the plants from the places in which they most abound.

(965.) The Gramina are the simplest of the truly flowering plants, and, from the comparative simplicity of their structure, they seem to invite the earliest consideration. They are readily distinguished from the previous class by bearing evident flowers, which flowers consist essentially of *ovules*, [§ 969, fig. *d*,] that when ripe become seeds; of *Pistilla* or pointals [*b*, *c*], and of *Stamina* or chives [*a*]: these parts are invested or covered by several series of modified leaves, called *Glumes* or husks, [§ 971, B, F,] and termed collectively a *perianth:* the glumaceous nature of the perianth is one of the most distinctive characters between the grasses and the following groups of flowering plants. From being the earliest instances in which true flowers are found, although simple in their structure, the morphology of the several parts is less clearly understood than in the more elaborate flowers and fruits of the subsequent classes: for, in them, the organs that are seen here in their primary or rudimental state, become further developed and more perfectly evolved.

(966.) The articulated, hollow Stipitellæ of the jointed ferns, bring them, in their organs of vegetation, the nearest to the cereal grasses of any of the ferns; and their organs of fructification, although very obscure, still, as it were by proxy, introduce the student to the more elaborate and distinct organization of the seeds, and their subservients, which are found in the superior grades. The fibro-vascular stems of the grasses remind the physiologist, both by their structure and their subterranean or creeping

habits, of the prostrate or subterranean Stipites of the ferns; and the culms or straws which spring from them are analogous to the Stipitellæ, or fronds, previously described.

Siliceous deposits similar to those found in the Equisetinæ, (and from which, as they injure the mouths of cattle, they have been called shave-grasses,) are likewise met with, but in a less degree, beneath the cuticle of grasses; and the leaves of one order of the Gramina, springing from the nodi and surrounding the stem with a sheath, bear a resemblance to the vaginal enclosures of the Equiseta which are found at every joint; or perhaps these annular sheaths are more analogous to the membranous processes or ligulæ at the bases of the leaves. Furthermore, certain arborescent grasses, as the bamboos, raise their stems above the surface of the earth, in like manner as do the arboreous ferns, and are met with in tropical countries, even exceeding many trees in height.

(967.) The internal structure of the subterranean stems of grasses, and that of their superterranean culms, consists of a mass of cells traversed by tubular vessels, some corpusculiferous, some false tracheæ, and some true spirals; which latter tubes were, in the previous class, either entirely absent or rarely found, or, if present, few in number, and in a very rudimentary condition. At each joint, whenever joints are found, the fibres interlace and form a solid knot, which remains, as it does in the Preles, even after the development of the neighbouring parts has formed, as in them, a cavity in each internodium. From the knots the leaves spring, and by their bases enclose the culm with a sheath-like expansion or vagina, which in the one order is *entire*, in the other *cleft* [§ 969, *c;* A]; the tubular vessels run in right lines, or nearly so, from the exsertions to the points of the leaves, without any interweaving or reticulation; at the lower part of the culms the nodes are usually much nearer together than in the upper; and from those which are beneath the ground, roots spring, which always regulate the supply of food to the plant as drawn from different depths; and, however deeply the seeds may be sown, will, if they grow at all, bring the chief roots as near the surface of the soil as those of seeds which have originally been placed at a proper depth. In the axillæ of the leaves, buds are likewise formed; those which are produced below the surface of the soil become developed, and serve to form the large tufts of culms for which the more prolific grasses are notorious. The increase by these offsets, which often

takes place to a vast extent, is called tillering: and hence it is that one grain of wheat will often produce twenty, thirty, forty, or even fifty, or one hundred culms, each bearing sixty, seventy, eighty, or one hundred grains; a most prodigious increase. A tuft of grass is thus very similar to a compound bulb, such as the garlic, the coats of which have been loosened or become obsolete. The general axis of the plant is abortive, and therefore all the leaves and flowerstalks, which indeed form the culms or branches, are sessile on the subterranean rhizoma. Often the rhizoma, still prostrate, is lengthened, as in the *Irises* and the *Ferns*, and the culms or branches spring up at intervals from the nodi, as in the plants referred to, while again, on the other hand, the rhizomata occasionally become erect, and arborescent, like both palms and pines; and, when the aerial buds are developed in the axillæ of their leaves, they are even furnished with branches, as in the bamboos.

(968.) The grasses have been said to be less truly *endogenous* than any other monocotyledonous plants. This assertion is, however, scarcely correct, and probably arose from not sufficiently attending to the distinction between the *culms* or *branches*, and the rhizomata or true stems; for the underground stems, even of the herbaceous grasses, have the unstratified structure of the palms and ferns; and as to the internal similitude of the arboreous stems of the bamboos there can be no doubt. Their external conical form, resulting from the development of their lateral buds as branches, is, however, an important deviation from the normal appearance of the *Endogenæ*, and is probably alluded to by Agardh; but even this aberration is not peculiar to the grasses.

(969.) The fistulous culms in one order cause the tubular vessels to be arranged in a circle round the central cavity, as in the Stipitellæ of the Equiseta; but even in them the whole at first was solid, and the inter-articular vacuity is caused by the growth of the fibrous tissue being more rapid than that of the cellular parenchyma; to which parallel instances might be cited from other Endogenous and Exogenous plants; as the common onion, the hemlock, and most umbelliferæ. In the sedges, the culms, which in the other grasses become hollow, always remain solid, and, at the imperfect nodi which occasionally are found, there are no diaphragms, so that they would seem to have been arrested in the progress of their development, or to be forerunners of their

more highly developed associates. That the sedges are the least perfect of the two orders into which the Gramina have been distributed is evident, not only from the structure of their mature stems being analogous to that of the infant form of their allies; but also

Carex pendula.

Upper part of the culm, shewing the superior position of the Staminiferous spikes and the inferior of the Pistilliferous ones, the linear venation of the leaves, the entire sheaths, and the absence of ligulæ.

(*a*) Staminiferous flowers, with erect innate anthers.

(*b*) Pistilliferous flowers enlarged, to shew the germen or ovary style, the three plumose stigmata, and the keeled bracteæ.

(*c*) The double scale at the base of the fertile flower.

(*d*) The fruit enlarged, and cut transversely.

from the much more rudimental state of their floral organs; the modified leaves or bracteæ, which are external to the essential parts, being in fewer series, and often reduced to the condition of hairs or bristles. These, and other important differences in structure, have led botanists to confirm the popular division of the grasses into two orders, the *Cyperöideæ* and *Gramineæ* of Jussieu, the *Cyperaceæ* and *Gramineæ* of De Candolle, the *Cyperales* and *Graminales* of the present system.

(970.) Although the culms or branches in the *Cyperales* or sedges are knotless, their true stems or rhizomata have nodes, which become occasionally swelled into tubers [§ 984, B]; and, as the leaves and flower-stalks both spring from the crown of the root, the latter resemble the scapes of many bulbous plants, or are rather analogous to the upper parts of the culms of the Graminales, in which the nodes become more and more distant, and the internodia lengthened, until the inflorescence begins, when the axis is again reduced, and the modified foliage converted into flower and fruit.

As the more important organs which are common to both orders are most easily demonstrated in the latter, the following detail will refer especially to the Graminales, and the peculiar characteristics of the sedges will be subsequently described.

(971.) Towards the upper part of the culm in grasses where the nodes are more distant, and the internodia lengthened, the leaves become much smaller, and are at length so far contracted

A. *Avena sativa.* (*a*) Panicle of flowers, with a locusta separate. B. One flower separated. (*a, a*) The two valves of the glumelle. (*b*) The stamina. (*c*) The pistil. (*d*) A stamen separate, to shew its filament and anther. (*e*) The pistil, separate. (*d*) The valves of the glume. D. The lower, and E the upper, part of the culms of *Oryza sativa.* F. A flower shewing (*a*), the two glumes, and (*b*), the two glumellæ. G. A flower with the husks removed, shewing (*a, a*), the six stamina. (*b*) The two pistils, at the base of which are the glumellulæ or nectary scales.

and changed in appearance, that their names are also changed: they are called *bracteæ*, or more commonly glumes (glumæ), or husks. Within these glumes, when present, are contained the organs of reproduction.

(972.) These glumes or husks, consisting of one or more *bracteæ* or *valves*, sometimes called *Spathæ*, either spring immediately from an undivided culm (a simple axis) or *rachis*, when they are said to form a *spike*, or, if stalked, a *racemus*; when they are set more or less diffusely on a branching axis or compound rachis, they are said to form a *panicle*, which may be either co-arctate [§ 971, fig. E,]

or diffuse, [A.] Each division of the spike or *panicle, i. e.* the collection of two or more florets in the glume, is called a *spikelet* (spicula) or locusta, [§ 971, fig. A, *d*, F.]

(973.) The spikelets or locustæ may either be one, two, three, or many flowered; the inner and finer bracteæ are called the *glumellæ*, [§ 1005, *k*,] and the valves or pieces of which they are composed, *paleæ* or *spathellæ*. Within the Glumæ and Glumellæ are found, in general, two smaller scales, [§ 1005, *m*,] which have been called the *Glumellulæ*, *Spathellulæ*, or *Lodicules;* and these immediately surround the fruit. The Gluma is called a calyx, the Glumella a corolla, and the Glumellula a nectary, by Linnæus and Smith.

(974.) Formerly these three series of coverings were likened to, and named after those organs in more highly developed plants, towards which they are transitions from ordinary leaves; but, as they are distinct in character, it is better they should have also different names; and their analogy to calyx, corolla, and nectary, is quite as evident now that the Glumes, Glumelles, and Glumellules, are considered what they are, viz. gradations of bracteæ, as when they were assumed to be what they are not, viz. *sepals, petals,* and so forth.

(975.) From the valves of the glumes and the glumellules are sometimes continued thin hair or thread-like processes, which, if they are evident continuations of the nerves of the bracteæ, and are exserted from the margin, are called *bristles* (setæ); if they are not, but arise from the base of the glumes, or leave the expansion before arriving at the edge, they are called awns (aristæ,) [§ 1005, c, *c*, *l*.]

(976.) Those organs, which in the ferns are only evident after the granules begin to vegetate, and which are probably in them *produced,* not *educed* by germination, exist in the fruit of the grasses previous to its separation from the parent plant, and constitute the contents of these fruits, true seeds of that kind called *grains*, whence these vegetables have been by some denominated *grain-bearing* or *graniferæ*.

(977.) The divisions of the rachis or extremity of the common axis, which bear flowers, are called *peduncles (pedunculi,)* or flower-stalks, and the ends of the peduncles or the points of the rachis whence the flowers spring, are called *receptacles, thalami,* or *bases*.

(978.) The organs previously foreshadowed, but here present, are,

first, the *chives* or *stamina*, which are situated within the *Glumelles*. They consist of a thread called a *filament* (*filamentum*,) which supports a two-celled case or theca, called an *anther* or *summit*, within which are numerous small cellules, termed *pollen*, each of which is a minute membranous bag, containing a substance of different degrees of fineness and tenacity, which has been named the *fovilla*.

(979.) In some florets no further organs are found, and such florets are termed staminiferous or barren [§ 969, fig. *a*]; but in other flowers a central body is perceived [§ 969, *b*; 984, *h*], called the Pistil or Pointal, from its occasional *pestle* shape and occasional pointed extremity. The base of this pistil is in general tumid, and is called the *germen* or *ovary*; from it rises a column of greater or less extent, denominated the *style*, which is crowned by a capital named the *stigma*. Sometimes the style is absent, and then the stigma is said to be *sessile* on the ovary. If the floret contains a pistil only, it is said to be a *Pistilliferous* or pistil-bearing flower; and, when both stamens and pistils arise from the same receptacle, the flower is said to be mixed or united. With regard to relative situation, the stamens, when in the same flower with the pistils, are exserted from the rachis or receptacle below the germen; and this disposition is said to be hypogynous.

(980.) The germen or ovary, which becomes the fruit, consists of an ovule or ovules, which are the rudiments of future seeds, and of an outer covering named the pericarp, which in the cereal grasses adheres very closely to the seed; the fruit hence receives the name of *caryopsis*, a word (derived from καρυα and ὄψις,) signifying a resemblance to a seed, in reference to the obscurity of this seed-vessel leading many to suppose it to be absent, and to believe the seed to be uncovered. In the sedges the pericarp does not adhere to the seed, and hence their fruit is called an Achenium. When, during the economical process of converting corn into flour, the pericarp is separated by mechanical means, it constitutes bran.

(981.) The seed consists of several other parts, some of which are only in a rudimentary state in grasses; and hence their description shall be deferred until they are more fully evolved. The other organs which now need demonstration are, first, a minute body called the *Embryo* or *plantule*, and a reservoir of food laid up for its support during the infantile period of its growth, which bag of starch is called the *Albumen*, [§ 984.] Sometimes it includes the embryo, at others the embryo is free.

(982.) The embryo itself consists of one, or rarely two half-leaf-like scales, which are called *cotyledons*, and of a gemmula, and a radicula, minute organs destined to become the future stem and root. In the grasses, the radicula is enclosed in a sheath, which is called the root-case or *Coleorhizon*, and all plants which have the radicule thus enclosed are termed *Endo*-rhizous.

(983.) These are all characters of importance in the systematic arrangement of the plants in which they are found, for by the most general ones the Gramina are associated with the other classes to which they are naturally allied, and by modifications of the more special ones they are distributed into orders, sections, types, and genera, analogous to the divisions that have been illustrated in the preceding groups.

CYPERALES.

(984.) This order includes all those grasses or grass-like plants in which "the embryo is within the Albumen, one or more series

A. *Cyperus rotundus*. (*a*) Lower part of the stem. (*b*) Sertulate inflorescence. (*c*) Tubers formed by hypertrophied underground culms. (*f*) Bracteæ or glumes, side view. (*d*) Back view. c. Carex arenaria, shewing its creeping stem, imbricate glumes, and spicate inflorescence. (*g*) Glume. (*h*) Essential organs of the flower, viz. stamina and pistil, shewing its ovary, style, and three stigmata. (*e*) Imbricated glumes of Carex hirta. Unlettered figure, a section of the seed of Scirpus supinus, shewing the Albumen, including the Embryo.

of the glumaceous perianth suppressed, the leaf sheaths entire, and destitute of ligulæ, and the culms solid, angular, and knotless." The absence of nodes from the stems of the sedges, if not absolutely universal, is very nearly so, and, from the facility of application, this has long been one of the most popular diagnostics. Among the Romans its acknowledged truth gave rise to the common proverb, 'nodum in scirpo quæris:' in scirpus sylvaticus, however, imperfect knots are found. Although differing in the above characteristic particulars, the *sedges* (Calamariæ of Linnæus,) agree with their immediate allies, the grasses, in the husky nature of the bracteæ that form their floral integuments, which are hence called *glumes* in both orders; the outer bracteæ of each floret or spikelet is, in the sedges, always solitary, *i. e.* they have one-valved glumes which overlie each other like gutter-tiles, and hence in their disposition said to be *imbricated*, [§ 969 and 984.] From the axillæ of the glumes the stamina, variable in number, but generally three, and the pistilla usually arise, sometimes uncovered by any further floral integuments, sometimes with the inner bracteæ, *Spathellules* or *Glumellules*, developed in the form of bristles (*setæ*,) and even evolved as scales (*paleæ*) like the Spathellules of the grasses; yet even here the Glumellule consists of only a single valve, or, if of two, they are united, as in Carex, [§ 984, *g*.]

(985.) The florets, as in the other grasses, may be either staminiferous, pistilliferous, or united, and the stamens and bracteæ, being all seated below the germen, are said to be, as before explained, hypogynous. In some of the sedges, the separated florets grow on the same plant, although the stamens and pistils are not in the same flower, when they are said to be monœcious, or dwelling in one house: at other times the separation is still more complete; one individual plant, bearing only staminiferous florets, and another of the same species only pistilliferous, when they are said to be dwelling in two houses, or to be *diœcious*. The germen contains a single ovule: hence the ovary is one-seeded, (or monospermous,) and the seed-vessel (pericarpium) being separable from the seed, is called an *achenium;* occasionally the valves of the glumelle are persistent; and, if they become partially succulent, the fruit has been called, though improperly, a subdrupaceous achenium. The seed is erect in its pericarp, and consists of an albumen, which, from its surrounding the embryo, is called perisperm.

(986.) This order contains two sections, which differ in having

the one united, the other separated flowers. From the normal genera, *Cyperus* and *Carex*, these sections are named the *Cyperinæ* and *Caricinæ*.

CYPERINÆ.

(987.) The genera included in this section are indicative of two grades of development, and hence they are distributed into two types. In the paper-reed (*Papyrus*), the Galingale (*Cyperus*), and their immediate allies, the united florets are destitute of glumelles; while in the rush-sedge (*Scirpus*,) the wool-bearer (*Eriophorum*,) and others, the flowers, although still united, differ in having the glumelles present, with form of hypogynous hairs or bristles, of different lengths, with which the germen is surrounded. These two types are called the Papyraceæ and Scirpaceæ, from *Papyrus* and *Scirpus*, the most familiar examples they respectively afford.

(988.) Papyraceæ. The *Papyrus antiquorum* is a plant of classical celebrity; as from it the Egyptian *papyrus*, and the chief of the paper used by the ancients, was procured; and the manufacture, though now obsolete, was continued to the beginning of the eleventh century. *Babeer*, the Syriac name, is said to be the root of the Greek and Latin words παπυρος and *papyrus*, and of the English *paper*. The former uses of this plant were many. Antigonus is recorded to have had the ropes and cables of his fleet made from the stalks. Pliny says that boats were constructed of it, and Bruce confirms this statement; for he says that in Abyssinia they have no other vessels. The Papyrus is indigenous to Ethiopia and Egypt, and, although generally preferring stagnant waters, Bruce found it growing in the rapid course of the Jordan; and he there remarked that it constantly opposed one of the angles of its stem to the current, as if to elude the violence of the waves. The roots of papyrus were chewed for the pleasant juice they yield, and the Egyptians used to roast their stalks, and eat the soft pulpy matter they contain. Matthiolus recommended the introduction of small portions into fistulæ as tents.

(989.) *Cyperus* is a very large genus, containing upwards of 250 known species, very few of which are either esculent, or of much value as medicines or in the arts.

C. esculentus (the *Souchet comestible* of the French,) bears tubercles about the size of nuts on its underground stem, that are

replete with starch; and in many places, as in Egypt and Manilla, they are much eaten. When roasted, they have been used as a substitute for coffee. *C. longus* and *rotundus* are both good stomachics. The roots of the former have a pleasant smell of violets, but they are too bitter to be eaten in any quantity. One of these plants is said to have been the κυπειρος of Dioscorides; and, from its reputed aphrodisiacal powers, it received its name. Major General Hardwicke states, that the roots of C. rotundus have been given with benefit in cholera: the native practitioners call it *Mootha-ghas*. *Nagur-mootha*, the roots of which the Indian damsels use for cleaning and perfuming their hair, is the *Cyperus perennis*. *C. juncifolius* is said by Ainslie to be both diaphoretic and diuretic; and *C. articulatus* is esteemed in Guinea as a vermifuge. The nut-grass of the West Indian planters is the *C. hydra*. This plant is the pest of the sugar-grounds, as it overruns them, and renders the canes barren. The subterranean tubercles of various species of Cyperus, especially *C. esculentus*, contain a considerable quantity of oil, to which they owe their nutty flavour and fragrant smell.

(990.) *Schœnus*, derived from σχοινος, a rope or cord, because from these plants cables and cordage once were made, is a generic name now given to a large group of sedges of no very great economical importance: they abound on the banks of water-courses, and in wet cold lands, and thus afford a scanty pasturage where better grasses will not grow. *Schœnus* or *Cladium mariscus* flourishes in vast profusion in the fenny parts of Cambridgeshire: there hundreds of acres may be seen covered with this plant, and with it all the fires are constantly lighted in Cambridge, and in the neighbouring towns.

(991.) Scirpaceæ. *Scirpus*, another large genus, includes the bullrush (*S. lacustris*), with many other rush-sedges, some of which, such as the *S. maritimus*, that grows abundantly in the salt marshes, are much relished by cattle. *S.* or *Eleocharis cæspitosus*, the deer's-hair turf, forms, according to Hooker, the principal food of sheep and kine, in the Scottish highlands, for about three months in the spring of every year. *Scirpus tuberosus* is the *Pi-tsi*, or water-chesnut, of the Chinese: it is there cultivated in tanks, which are regularly manured, and the water at intervals drawn off. The tubers are eaten both raw and cooked, and are esteemed both as food and medicines. Withering says

that the roots of our *S. maritimus* are esculent, and that they have been ground, and used instead of flour, in times of scarcity. The leaves of several of the sedges are employed under the names of rushes, especially the *S. lacustris* or bull-rush, for making chair-bottoms, matting, and other domestic purposes.

(992.) *Eriophorum*, the cotton-grass or wool-bearer, is very common on most of our bogs and moors. Several of the species are very elegant plants, bearing in their spikes of flowers long tufts of silky-looking hairs. In Lapland this vegetable silk is woven into various fabrics, and it is used, both there and elsewhere, as stuffing for mattresses and pillows. *E. polystachion*, the bog-flax, is a popular remedy in cases of epilepsy.

(993.) The types *Scirpaceæ* and *Papyraceæ*, which differ in the presence and absence of rudimentary glumelles, the latter having none, and the former having them in the state of hairs or bristles, are associated to form the section *Cyperinæ*, their united flowers being the common collective sign.

CARICINÆ.

(994.) In *Carex*, *Trasus*, *Kobresia*, and *Uncinia*, the flowers are separated; the stamina and pistilla being situated in different flowers, either on the same or on different plants; the glumelles also, which in the *Cyperinæ* were either wholly absent, or only produced in the form of hairs, are here developed as true valves, which in Carex invest the germen, and, being persistent, afford it an adventitious tunic.

(995.) Caricaceæ. *Carex* is the largest and most important genus included in this type, which stands alone in the section *Caricinæ*; the distinctive characters of which are common to both. The Carices are for the most part homely looking plants, growing chiefly in wet and swampy soils: they are the especial inhabitants of bogs, fens, marshes, and moist woods, where they yield a very coarse grass, that is sometimes resorted to in scarce seasons, and in barren situations, as fodder for cattle. Their chief value consists in their flourishing in tracts on which no other, or at least no richer grass, would grow. The chief economical purposes to which the Carices have been applied, are as coverings for the Florence oil and wine flasks, and to put between the staves of casks, to make them tight. Carex leaves form the common ligatures with which hops in Kent and Sussex are tied to the poles; and

in Lapland the leaves of Carex sylvatica, and perhaps some other species, are combed and dressed as flax is in this country, and used as a warm lining or stuffing for gloves and shoes; and Linnæus says that, thus protected, the limbs of the Laplanders are never frost-bitten, notwithstanding the severity of the climate.

(996.) The roots of *Carex arenaria* are reputed to be diaphoretic, and to be possessed of demulcent and alterative powers. They are collected on the continent, and known under the name of German sarsaparilla. The roots of *C. disticha* and *hirta*, which have similar qualities, are mixed with those of *C. arenaria*, and are administered with advantage in rheumatic and cachectic affections.

(997.) The *Caricinæ* and *Cyperinæ*, which differ in having the latter united, and the former separated flowers, agree in the more general characteristics pointed out in [§ 984], and form collectively the order CYPERALES. The Linnean term *Calamariæ* is untenable, as the genus *Calamus* is a palm, and none of the sedges are reeds: and De Candolle's modification of Jussieu's Cyperoideæ is objectionable, as having the termination, which is here, for the sake of perspicuity, restrained to the subordinate types.

GRAMINALES, OR POALES.

(998.) The *true* grasses, as they are sometimes called, to distinguish them from the *sedges*, (which, although *grasses*, do not fatten,) are well characterized as an order, by the reverse development of almost every part, the general structure of which associates them with the Cyperales. Thus, in the Graminales the culms are round, hollow, and jointed, instead of being angular, solid, and jointless; the leaf-sheaths are slit and furnished with ligulæ, instead of being entire and exligulate; the bracteæ are developed in several series, and evolved as perfect glumes, instead of being few in number and in a rudimentary state; the pericarp is adherent to the seed, so that the fruit becomes a caryopsis, instead of being separable and forming an achenium; and in the last place, the lenticular embryo is external to the albumen, instead of being enclosed within it.

(999.) These strongly marked features, which associate the true grasses to form the order Graminales, and distinguish them so clearly from all other plants, render their subordinate distribution into types and sections more difficult than in other groups where less

uniformity prevails, and in which, though the general characters agree, their agreement is less exact. It may however be observed, that for some of the most important purposes of natural arrangement, such as the predication of the properties of unknown plants, subordinate distribution is less necessary and of less consequence in the Graminales than in other orders of equal extent, where vast differences occur in the habits, qualities, and uses of the minor groups they comprehend; for here the greatest similarity pervades the whole. Thus, all the genera afford food to animals; the leaves form pasturage for cattle, the smaller seeds are the chief support of birds, and the larger the staple sustenance of man: and, out of nearly two thousand species, scarcely more than one is really unwholesome.

(1000.) The Graminales have been popularly distinguished into corn and fodder grasses (*Gramina cerealia et pascualia*); but these, although useful distinctions in an agricultural point of view, as indicating the chief purposes to which the multitudinous species are applied, are not founded upon any structural differences, and therefore, as systematic sections, cannot be adopted or defended.

Many of the present cereal grasses once yielded seeds unfit for food; and several of those now used for pasture only might have their seeds converted into corn; indeed, some, as the *Zizania fluitans*, will probably before long be naturalized to this country, and change our marshes into corn-fields.

(1001.) But, although not essentially necessary, on account of difference in properties, to distribute this order into minor groups, it is convenient, for practical purposes, that some subordinate distribution of the genera should be made. Many schemes have been proposed, but it is doubtful whether any hitherto devised will be generally adopted. The sections recommended by Dr. Brown are unobjectionable as far as they go; and, when more ample details than have yet appeared are published, his plan may probably supersede the one here given, which has chiefly its simplicity to recommend it.

(1002.) According to the views of Brown, the true grasses should be distinguished into two large groups or sections, one of which, from the genus *Poa*, or meadow-grass, he calls *Poaceæ*, and the other, from the genus *Panicum*, he terms *Paniceæ*. The Paniceæ are to be known "by having always a locusta of two flowers, of which the lower or outer is uniformly imperfect, being either staminiferous or neuter, and then not unfrequently reduced to a single valve." "The second tribe, *Poaceæ*, is more numerous than Paniceæ, and comprehends the greater part of the European species, as well as certain less extensive genera peculiar to equinoctial countries; it extends also to the highest latitudes in which phænogamous plants have been found: but its maximum appears to be in the temperate climates considerably beyond the tropics. The locusta in this tribe may

consist of one, two, or many flowers, and the two-flowered genera are distinguished from the Paniceæ by the outer or lower floret being always perfect, the tendency to imperfection in the locusta existing in opposite directions, in the two tribes. In conformity with this tendency in *Poaceæ*, the outer valve of the perianthium in the single-flowered genera is placed within that of the gluma, and in the many-flowered locusta the upper flowers are frequently imperfect. There are, however, some exceptions to this order of suppression, especially in *Arundo Phragmites*, *Campulosus*, and some other genera in which the outer flower is also imperfect; but as all of these have more than two flowers in their locusta, they are still readily distinguished from *Paniceæ*." (*Flind. Voy. App.*)

(1003.) Link, Kunth, Bartling, Palisot de Beauvois, and others, have constructed various systems for the subordinate distribution of the grasses; and, although the question has not been settled by their labours, they have collected materials which will be of the greatest use to all systematic graminologists. The method proposed by De Beauvois is very ingenious, but it is too artificial for a natural arrangement, and less simple as an index than the Linnæan clue.

As the plans of the three former are more natural than that of the latter, it is therefore upon them, especially upon Bartling's, that the following distribution has been founded.

(1004.) The most familiar of the grasses, and the best known, from their value, are undoubtedly the Rice (*Oryza*), the Wheat (*Triticum*), the Barley (*Hordeum*), the Oat (*Avena*), the Rye (*Secale*), the Maize (*Zea*), the Millet (*Sorghum*), and the Sugar (*Saccharum*:) and these, together, form a constellation that no other order in the whole vegetable reign can equal in importance.

The above, which are the chief of the cereal grasses, with the *Bamboo* (Bambusa), the bread-grass (Panicum), and various pascual genera, such as (*Agrostis*) the bent-grass (*Stipa*), the feather-grass (*Festuca*), the fescue-grass (*Phalaris*), the canary-grass, and (*Spartina*), the rope-grass, are examples of the several groups into which this order may be conveniently distributed, and some of them, as normal genera, give names to their respective types and sections; but it must be remembered that, although convenient divisions of an extensive order, they are not separated by any such decisive and notorious signs as to supersede the value of an artificial clue, or to make the reference of individuals to their types and sections always easy to those who have no other index to guide them in their investigations.

TRITICINÆ.

(1005.) *Triticum* (the especial *Granum tritum*), which Varro says received its name from the mechanical process of grinding, to which the seeds were subjected before being used as food, not improperly denominates the section, in which, besides the wheats, there are contained, barley, rye, and lyme-grass; and to which the millet, the panic, and the sugar, are nearly allied, although in another section.

(1006.) HORDEACEÆ. *Triticum* (wheat), *Hordeum* (barley), *Secale* (rye), *Lolium* (darnel), *Elymus* (lyme-grass), and nume-

A. Root and lower part of the culm of Triticum hybernum. (*a, b, c*) Leaves with split vaginæ or leaf-sheaths. (*d, f*) Nodi. (*e*) An internodium.

B. Upper part of the culm, shewing the spicate inflorescence. (*g*) A locusta or spikelet of T. Spelta. (*h*) The glumes. (*i*) The glumelles. (*k*) A flower of T. hybernum, shewing (*l*), the three two-celled versatile anthers. (*m*) The germen or ovary, with the two glumellules or nectaries, and (*n*) the two pistils.

C. *Hordeum distichon.* (*a*) The culm. (*b*) The leaf. (*c*) The spike of locustæ. (*d*) A flower separate, to shew the awn. (*e*) The stamina. (*f*) The pistils. (*g*) A flower magnified, to shew the three stamens with versatile anthers, one dehiscing and disclosing the pollen. (*h, h*) The two pistils. (*i*) The plumose stigmata. (*k*) The germen or ovary.

rous other genera, in which the sessile, locustæ, or spikelets, are crowded into terminal spikes; and the styles, in number two, form, collectively, the type *Hordeaceæ*.

(1007.) Wheat, (*Triticum*, [§ 1006, fig. A, B,] which is the principal bread-corn of most European nations, has been so much changed and improved by culture, that its connexion cannot be satisfactorily traced to any species of the genus now known to be growing wild. This, as well as our other cereal grasses, came to us from the east: and it has been asserted that the original stock still exists wild in Thibet. The testimony, however, is far from being conclusive. Wheat appears to be peculiarly sensible to the effects of soil and climate, for in different countries, and even in different parts of this island, the crops and their products are very various. Sicilian corn contains more nutritious matter than any grown in Britain, and Middlesex wheat is more nutritious than that grown in our northern counties. In Davy's Agricultural Chemistry a table has been drawn up, which very clearly illustrates the influence of soil, disease, and climate, upon the nutritive properties of corn, as well as shewing the superiority of wheat over the other cerealia: from it the following are extracts.

Whole quantity of nutritive matter in 1000 parts of each of the following grains:		Mucilage or starch.	Saccharine matter.	Gluten or albumen.	Extract or insoluble matter.
Middlesex wheat	955	765	—	190	—
Spring wheat	940	700	—	240	—
Mildewed wheat (1806)	210	178	—	32	—
Blighted wheat (1804)	650	520	—	130	—
Sicilian wheat, thin skinned	961	722	—	239	—
————, thick skinned	955	725	—	230	—
Wheat from Poland	950	750	—	200	—
North American wheat	955	730	—	225	—
Norfolk barley	920	790	70	60	—
Oats from Scotland	743	641	15	87	—
Rye from Yorkshire	792	645	38	109	—
Common beans	570	426	—	103	41
Dry peas	574	501	22	35	16
Potatoes	260 to 200	200 to 155	20 to 15	40 to 30	—

The chemical analyses of which this table gives the average results, shew that wheat not only exceeds other corn in the absolute quantity of nutritive matter it contains, but that the different proximate principles vary remarkably in their relative proportions, and the superiority of wheaten bread depends upon the large quantity of *gluten* that its flour contains. When separated by washing from the starch with which it is combined, gluten comes into the market under the name of Maccaroni, Vermicelli, &c. In Italy, and especially in Naples, there are immense quantities manufactured both for exportation and home consumption. It forms the ordinary and favorite food of the poorer classes in Italy, especially in the Neapolitan states; and Maccaroni is sold by the yard, at the corners of almost every street in the city of Naples. There is another advantage of no slight economical importance that wheat possesses over other grain; which is, that not only does its flour contain more nutritious matter, but that it yields a greater quantity; for fourteen pounds of wheat yield thirteen pounds of flour, while fourteen pounds of oats yield only eight pounds, and an equal quantity of barley but twelve pounds.

(1008.) Of other species of wheat, *T. junceum* is worthy notice from its natural uses in fixing loose sands; and *T. repens*, the couch-grass of the farmers, which is here regarded as a troublesome weed, is collected on the continent as food for horses. Cattle of all kinds are fond of the underground shoots of this plant, which are sweet and wholesome. Sir Humphry Davy found them to contain nearly three times as much nutritious matter as the stalks and leaves; and it has been stated, on the authority of a French veterinary surgeon, that exhausted and worn out horses are very speedily restored to strength and condition, by giving them, daily, one or two bundles of couch-grass of ten or twelve pounds weight each, mixed with carrots.

(1009.) *Hordeum*, barley, [§ 1006, fig. c], is said to have derived its name from *hordus*, heavy, as bread made from barley-flour wants that lightness and elasticity which the large quantity of gluten it contains gives to wheaten loaves. The Romans cultivated barley, as we do oats, for the food of horses; but they likewise ate it themselves, and it was considered to be such a strengthening food, that it was regularly supplied to the army; and the gladiators, when training, were fed upon it: hence indeed they were called *Hordearii*. The word barley is evidently

derived from *beard* and *ley;* and the name alludes to its beard-like awns: yet it is curious that the Hebrew for barley is בר; and that the Celtic, *bara*, signifies bread.

Barley is chiefly grown in this country for the use of the brewer and distiller, for the saccharine matter it naturally contains is much increased by the process of malting; and the sugar is subsequently converted into spirit. On the continent it is still grown as provender for horses. When barley has been decorticated it is said to be pearled; and its various preparations form a light food for the sick chamber.

Hordeum murinum, the wall-barley, or squirrel-tail grass, which grows so freely in all waste places, if allowed to insinuate itself into meadows, injures the hay, and lessens the value of the crops. Its strong beards or awns hurt the mouths of horses so much, that in the Isle of Thanet, where it is very common, it is said to be one of the greatest recommendations of an inn to have hay without squirrel-tails or beard-grass.

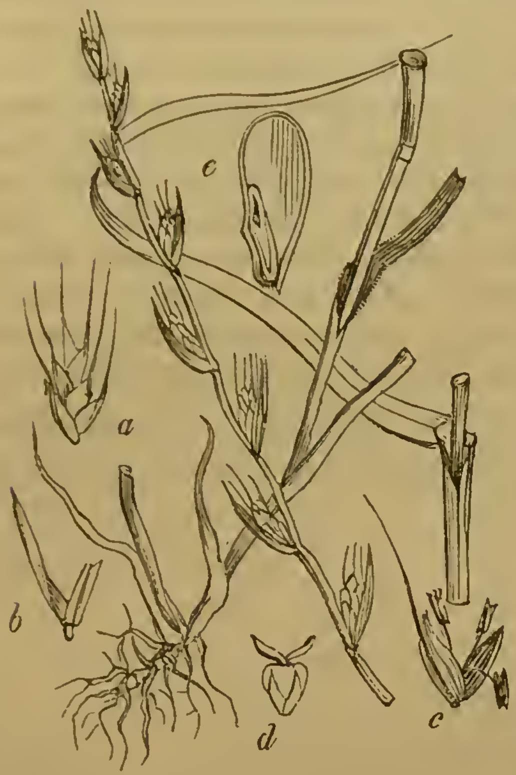
(1010.) Of the genus *Secale* there is but one, or at the most two, known species. *S. cereale* is the common rye, [§ 540, fig. E, D.] The name Secale is thought to be derived from *seco* (*secabilis*,) and to have allusion to its early subjection to the sickle, and, next to wheat, it is one of the most serviceable bread-corns. It is less nutritious than wheat, but it is both hardier and earlier, and will grow in many wet cold soils, where no other corn would yield a remunerating crop. From this habit, it is more liable to be attacked with the ergot than other grasses, and becomes then injurious, if eaten for any long time together, [see § 540, et seq.]

(1011.) *Lolium* or Darnel is a very common grass, and several species, as the *arvense*, *perenne*, &c. have been recommended to be sown among other grasses on poor cold soils; it affords a bulky crop of hay, and, although much less nutritious than the Fiorins and various others, it is more so than the fox-tail, cocksfoot, dogs-tail, and fescue grasses. And it is not unimportant for agriculturists to be aware, that experiments have shewn some of the grasses to contain two or three times as much nutritious matter as others. The following extract from Sir Humphry Davy's table, already quoted, will furnish several examples.

Meadow foxtail (Alopecurus pratensis)	33	Parts of nutritive matter in a 1000.
Darnel or ray-grass (Lolium perenne)	39	
Fertile meadow-grass (Poa pratensis)	78	
Crested dog's tail (Cynosurus cristatus)	35	
Spiked Fescue (Festuca loliacea)	19	
Sweet-scented soft grass (Holcus odoratus)	82	
——— vernal (Anthoxanthum odoratum	50	
Fiorin (Agrostis stolonifera)	54	
Fiorin cut in winter	76	

(1012.) The *bearded darnel* is generally supposed to be the "infelix lolium" of Virgil, of which he speaks in no measured terms of condemnation. It is not a

very common grass in Britain, but in warmer climates it is a noxious corn-weed, and, with the barren oat, overtops and chokes the wheat; so that Milne thinks it



Lolium temulentum cuttings, to shew the fibrous roots springing from a short rhizoma; the split-leaf sheath with its ligula and the linear venation of the leaves: and the spike of inflorescence bearing several sessile locustæ.

(*a*) A locusta removed.

(*b*) A portion of the rachis, to shew the single glume or bractea.

(*c*) A single flower with its two glumelles, awn, or arista, and three stamina with versatile anthers.

(*d*) The pistil removed, shewing the double ovary and two stigmata.

(*e*) A section of a seed, to shew the albumen or perisperm, and the embryo with its single cotyledon outside of the albumen.

highly probable that the Greek *ζιζανια,* which occurs in the thirteenth chapter of St. Matthew's Gospel, should be rendered *Darnel,* which would convey the meaning of the passage more fully than *Tares :* and, in accordance with this view, the French always translate it *ivraie,* from *ivre,* drunk. Our partiality for contractions has caused the corruption of the French ivraie into *ray*-grass, one of the names of darnel, although it properly applies to one species only, viz. the L. temulentum, which is said to possess intoxicating powers. Haller affirms that this species of Lolium not only produces intoxication, as its trivial name implies, but that, if baked into bread, or fermented in ale, its administration is attended by very disagreeable, and even fatal effects. It produces headach, vertigo, vomiting, lethargy, drunkenness, and difficulty of speech, and the tongue exhibits a very strong trembling. Seager further remarks, that a trembling of the body is one of the most certain signs of poisoning by this plant. It also affects with blindness for several hours, which peculiarity is noticed by Ovid, in his Fasti, (lib. i. 692.)

> " Et careant *loliis* oculos vitiantibus agri
> Nec sterilis culto surget avena solo."

This property gave rise to the old proverb, " he feeds on Darnel," which was applied to a short-sighted imprudent person; and thus, in Plautus, when Palæstro inquires what Sceledrus meant by his living on darnel, he receives for answer, " Quia lusciosus es ;" because you are purblind.

(1013.) By the Chinese laws, for this plant is found both in China and Japan, it is forbidden to be used in fermented liquors. Some of the intoxicating qualities of factitious beer are said to be owing to the admixture of darnel with the malted barley; and a few years ago, two acres of ground in Battersea-fields were

sown with this grain: to what good purpose it could have been applied is unknown, for, although darnel-meal was once recommended as a sedative cataplasm, it has been long disused; and, according to Withering, horses, geese, &c. are killed by darnel, and dogs are peculiarly subject to its influence: mixed in small quantities with their food, it is, however, said to fatten chickens and hogs.

In the "Medical and Physical Journal" there are placed on record several cases of poisoning by darnel, in the human subject. In these, giddiness in the head, pain and swelling of the limbs, succeeded by abscess and gangrene, were the most prominent symptoms. One of the sufferers lost both his legs. Various other cases, exemplifying the poisonous properties of this grain, have been condensed in the chapter on this plant, in the new edition of 'Medical Botany.' This, the only poisonous grass known, is easily distinguished by its two-sided spike and one-valved glumes; the glumes being longer than the bearded locustæ they enclose.

(1014.) Spartinaceæ (*Chloridea* of Bartling.) *Spartina*, the rope-grass, gives name to this type, which differs from the foregoing, by the sessile locustæ being crowded into unilateral spikes. The locustæ are either one or many flowered, the upper flower being imperfect. The styles are two, and the glumes keeled.

(1015.) The Spartinæ, with various other tough grasses, are used by the Spaniards for making ropes; and hence the generic name is said to be derived from the Spanish *Esparto*. Compared to the previous type, this includes very few important plants; Eleusine (from *Eleusinia*, an epithet of Ceres,) being almost the only genus that requires especial notice. Thunberg says, *E. coracana* is cultivated as corn in Japan; and Ainslie adds, that crops of it are raised for food upon the Coromandel coast, where it is called *Natchenny*.

(1016.) The types *Hordeaceæ* and *Spartinaceæ*, in both of which the locustæ are sessile, the inflorescence spicate, and the styles two, are thus associated to form the section *Triticinæ:* the first type of the following section is closely connected by its inflorescence with the last in this; but the upward suppression of the flowers and the carinate glumes, will always distinguish the Spartinaceæ.

PANICINÆ.

(1017.) Two types are contained in this section, which, from their respective normal genera, Milium and Saccharum, have been called the *Miliaceæ* and *Saccharaceæ*. They are associated by having the lower florets of the locustæ imperfect, and the glumes keel-less; and are distinguished by the latter having the spikelets articulated with the rachis, and the former non-articulate.

(1018.) Miliaceæ. In this type the inflorescence, which for

the most part resembles the last by having the spikelets often crowded in one-sided spikes, a tendency is shewn to the following section by the spikes becoming racemes, and occasionally, although rarely, panicles; the chief differential characters are found in the one or two flowered locustæ, becoming imperfect from below, and in the glumes being distinct, and not keeled.

(1019.) *Panicum:* the genus which denominates this section is thought to have been one of the earliest grasses the seeds of which were used for making bread, and that the names *panicum* and *panis*, have therefore more than a mere etymological affinity. P. miliaceum (the common millet), is still sown in this country, and occasionally used for making puddings, as a substitute for rice; but much more frequently for feeding poultry. P. arborescens is an extraordinary grass; for, although the culm is not thicker than a goosequill, it is said to exceed in height the loftiest trees of Hindoostan, shooting through their branches, and overspreading their summits, as it were with an aerial meadow.

(1020.) SACCHARACEÆ. The inflorescence in this type is rarely spicate, the locustæ being for the most part scattered in panicles; shewing a still closer approach to the Paniculate *Festucinæ*.

In Saccharum, [§ 71, fig. A, B, C,] and its allies, the one or two flowered locustæ are articulated with the rachis, and geminate, the one being sessile, the other pedicled, and, as in the preceding type, the suppression is found in the lowest flowers: the glumes are not keeled.

(1021.) Saccharum (sugar), the *Soukar* of the Arabians, is the most important genus included in this group. It is extraordinary that so fine a grass, possessed of such remarkable properties, should have been unknown to the ancients, or so little sought after by them, when they procured so many luxuries from the East. Galen and Pliny both mention a sweet salt that they call σακχαρ and *Saccharum*, and which was then only used in medicine. This sweet salt is presumed to have been sugar. Until a comparatively modern epoch its chief use was as a febrifuge, a small piece being recommended to be placed on the tongue, to relieve the thirst in fever. Actuarius, who flourished in the tenth century, first substituted 'Indian salt' for honey in pharmaceutical preparations. Like many other medicines it has escaped from the apothecary's store, and, from being dreaded as a drug, is now esteemed a luxury, or rather a necessary of life. In the year 1830, upwards of 193,663

3 A

tons of sugar were imported into this country; and in 1829 above 391,519,400 lbs. were retained for home consumption, each person on an average eating about a quarter of a hundred-weight per annum.

The sugar-cane is essentially an equinoctial grass, growing most freely in the hottest climes; it may, however, be cultivated to about the 40th degree of latitude on either side of the equator. Before the discovery of the West Indies, it was grown in the Mediterranean islands; and sugar is still made from the reed in several of the southern provinces of Spain.

(1022.) *Sorghum vulgare*, the Indian millet, is commonly cultivated as corn in Arabia, and most parts of Asia Minor; it has been introduced into the West Indies as a hearty food for the slaves, and is there called negro guinea-corn. In the southern parts of Europe, as in Spain and Italy, it is likewise grown. The flour is white, and is made into loaves or cakes; but it is chiefly used for feeding poultry and cattle. It grows five or six feet high, is a handsome plant, and its long awns protect the grains from the rapacity of birds.

Andropogon is another genus in this type; one species of which (*A. schœnanthus*) has an aromatic bitter flavour, and fragrant smell. The Indian practitioners esteem an infusion of the roasted leaves an excellent stomachic; and in the Moluccas a fragrant essential oil is procured from the culms and leaves.

Anthoxanthum odoratum, the sweet-smelling vernal grass, has likewise a very fragrant odour. Its glumes are covered with small dots, which are probably secreting organs. The odour of this plant is owing to the benzoic acid it forms; and it is remarkable for being scentless, while growing, but giving out, when cut, the very pleasant smell which is characteristic of new-mown hay. It has been proposed to enrich pasture-lands, and to improve the flavour of mutton, by sowing this grass where it is not common. On some downs it is abundant; but, as it flowers early, a difficulty occurs in the collection of its seeds. The benzoic acid found in the excretions of graminivorous animals is believed to depend on their consumption of this plant.

(1023.) The types *Miliaceæ* and *Saccharaceæ* are, by their mixed inflorescence, intermediate between the spicate *Triticinæ* and the paniculate *Festucinæ*. They are associated to form the section *Panicinæ*, by the important character of the suppression in

their flowers taking place in the lower or outer florets; their glumes are likewise keel-less; by which characters the spicate genera may be distinguished from the *Hordeaceæ* and *Spartinaceæ*, and the paniculate ones from the following types.

FESTUCINÆ.

(1024.) As some of the Panicinæ anticipated the paniculate inflorescence of the Festucinæ, so some of the Festucinæ, by the congestion of their panicles, repeat the spiciform inflorescence of the Miliaceæ and Triticinæ; and this is the most evident in the border type, in which however the locustæ, on examination, will be found to be truly panicled; the ambiguous appearance depending on the shortening of the flower-stalks.

(1025.) PHÀLARIDACEÆ. In Phalaris, and its allies, the paniculate locustæ are crowded into the form of a spike; the spikelets are one or two flowered, the upper being imperfect; the glumes are distinct and keeled; the stamina three.

(1026.) *Phleum*, the cat's-tail, *Alopecurus*, the fox-tail, and several other pasture-grasses, not of the richest kind, (§ 1011,) are found in this type. They are chiefly valuable as growing on poor soils; and the Alopecurus, for the bulk and weight of hay that it produces, which is greater than is afforded by any other grass.

The *Phalaris canariensis* is cultivated in this country for the sake of its seeds, which form the common food of canaries and other singing birds. The chaff is relished by horses, but the culms are short, and it produces but little fodder. It is chiefly grown in the Isle of Thanet. Crops may also be yearly seen near Canterbury, and in other parts of Kent.

(1027.) AVENACEÆ. *Avena*, *Briza*, *Glyceria*, *Poa*, *Bromus*, *Festuca*, *Dactylis*, *Arundo*, and numerous other genera, in which the "locustæ are paniculate, and two or many flowered, the imperfection being in the upper florets," are associated to form this type, which is the largest in the section. With the exception of the oat, it chiefly consists of pascual genera.

(1028.) Oat is a Saxon word (ate), and seems to be connected with the verb, *to eat*. The oat is the grain of cold countries, where it is considered bread-corn, and used as food for men. In the more temperate regions it is chiefly cultivated as horse-corn; but in warm latitudes the ears become so small, and the grain so poor, that it always affords an unprofitable crop. Oatmeal cakes and

porridge are still common as food in our northern provinces; and oatmeal gruel, as well as the various preparations of the grain, in the several forms of common, split, Embden, and patent groats, are familiar articles in the sick man's bill of fare. The last named is the purest oat-flour, and one of the lightest and pleasantest kinds of simple farinaceous food.

(1029.) The animal oat, which is often regarded with wonder, is the awn of the *Avena sterilis:* it is so delicate an hygrometer, and so exceedingly sensible to changes in the moisture of the atmosphere, that it is kept by ordinary vicissitudes in constant (apparently spontaneous) motion, and thus resembles some strange insect crawling about.

(1030.) *Glyceria aquatica*, the water sweet-grass, and the various species of *Poa*, are valuable as fodder. The former grows freely in wet marshy situations, such as the fens of Lincoln and Cambridge shires, where it is sometimes cut three times a year. Its growth is so rapid, that it fills up ditches and water-courses, and thus often becomes a formidable antagonist to draining fens. The lodes in the Isle of Ely are said by Curtis to become thus encroached on, and they are obliged to be cleansed by dragging a machine called a bear up and down the streams, which cuts the plants up by their roots.

(1031.) The *Bromi* are not very valuable pasture grasses, being chiefly coarse-leaved annuals. Loudon states that "the seeds of *Bromus secalinus*, which are often found in wheat and rye crops, are believed to impart a bitter taste to the bread, and to have similar narcotic qualities to the Lolium temulentum. In Scania, the panicles are used to dye green. The seeds of *B. mollis* are also said to bring on giddiness in men and quadrupeds, and to be fatal to poultry." *Rye* was formerly supposed to degenerate into *Brome-grass;* hence B. secalinus, and multiflorus, are still called *smooth rye*, and *downy rye:* hence also the former received its specific name.

(1032.) *Arundo*, the reed, shews a tendency, in some of its species, to become arborescent. *A. donax*, which is common in the south of Europe, is used in Italy, Spain, and Portugal, as fence-wood, vine-poles, fishing-rods, &c. From the two latter countries large quantities of these reeds are exported, to supply the wants of the anglers and weavers of Britain. *A. Phragmites*, which grows profusely on the banks of the Thames, is encouraged to

cover embankments, as the running roots confirm the river walls, and prevent the wasting action of the water. The culms of this reed make the best thatch known; they are likewise much used to form the substratum in plaster floors.

(1033.) The *Festucæ*, or fescue grasses, are many of them valuable for pasture. *Festuca ovina*, the sheep's fescue-grass, is met with in great quantities on the downs; and, its fine foliage being well fitted for the mouths of sheep, it is supposed to contribute to the superiority of the Southdown mutton. This is one of the best grasses for bowling-greens and lawns; it is soft, fine, and does not require frequent mowing; it likewise roots deeply, and therefore keeps green in dry weather.

(1034.) Agrostidaceæ. In Agrostis, and its allies, which form this type, the paniculate locustæ are one or two flowered, the upper florets being imperfect; and the glumes and glumelles submembranaceous.

(1035.) The *Agrostides*, as their name implies, are field or meadow grasses: the most valuable species is the *A. stolonifera*, or fiorin, which is remarkable for its fertility. It was one of the species noticed by Dr. Maton among the Orcheston long grass, specimens of it, and of Poa trivialis, being found seven feet and ten feet long. Two acres and a half of land in this district (near Salisbury) yielded, according to the account published in the Linnæan Transactions, the astonishing quantity of ten tons of hay in one year. A. stolonifera is one of the couch-grasses of the farmer. The creeping underground stems are replete with nourishment, and, in Italy and the South of France, they are collected by the poor people, and sold as food for horses. They contain much saccharine matter; and it has been proposed to ferment them, and brew table-beer.

(1036.) Stipaceæ. Stipa, the feather-grass, and a few other not very important genera, are found in this type: they are associated by having "their paniculate locustæ one or two flowered, the upper imperfect; the glumes are membranaceous, the inferior glumelle coriaceous, convolute, and awned; styles two.

(1037.) *Stipa pennata* is an exceedingly beautiful grass, small tufts of which bear a great resemblance to the tail and wings of a bird of paradise. Gerarde says, that in his time this grass was worn as an ornament by "sundry ladies, instead of feathers." *S. tenacissima* is one of the rope-grasses of the Spaniards.

(1038.) Oryzaceæ. The Rice, and its allies, which, collectively, form this type, are associated by having their "locustæ panicled and one-flowered; the glumes distinct, keeled, and the lower glumelle compressed and keeled; the stamina, for the most part, are more than three."

(1039.) The *Rice* (*Oryza*,) if estimated by the proportion of food it contributes to the sustenance of man, is the most valuable of all the grasses, and perhaps the most useful vegetable grown; as the unnumbered millions of the East are supported almost wholly on this corn, for the growth of which the extensive swamps of those hot countries, and their unrivalled means of irrigation, are peculiarly adapted. Rice is the staple corn of the tropics, as the oat is of the northern, and wheat of the temperate regions. The culture of rice is an exceedingly unhealthy occupation; for the frequent flooding of the fields keeps them constantly in a swampy state, and favours the production of malaria. Rice has been raised in England on the banks of the Thames, a crop having been gathered in near Windsor. In Italy it is cultivated with success; but artificial irrigation has been carried there to a higher degree of perfection than in any other part of Europe. Still it shrinks into insignificance if compared to the gigantic labours of the east, as will be seen from the following account.

"Between the fort of Nundydroog and the rising ground on which we stopped to view the prospect, there extended a valley some six or eight miles across, the whole bottom of which was marked with a succession of artificial tanks, used for irrigating myriads of rice fields lying below the level of these ponds.

"A young officer accompanied me the next day to the rock; and, what interested me fully as much as the traces of Lord Cornwallis's siege and successful storming of the fort of Nundydroog, in 1792, was the view from the top of the rock, and particularly the sight of a vast number of those extraordinary tanks or artificial ponds, for irrigating the rice fields, for which that part of the peninsula is so remarkable.

"The table-land of Mysore, which stands several thousand feet above the level of the sea, is not strictly a flat plain, as the name would imply; neither is it mountainous nor even very hilly; and yet the surface is extremely uneven, being moulded into gently sloping ridges, which form between them a succession of long valleys slightly inclined, broad and shallow, and winding about in all directions. Across almost every one of these valleys the natives have thrown embankments, some of them of very ancient date, though some are even so recent as the dynasty of Hyder. These walls or *bunds*, as they are called, are made of considerable strength, and when of small extent they generally curve upwards, so as to offer the convex side to the pressure of the water; but if they be a mile or several miles in length, the embankments assume a wavering snake-like shape; with what particular view I know not, but I suppose from some idea of strength.

One valley was pointed out to me, which might be about a mile broad and forty miles long from end to end: this included between thirty and forty tanks, some large, and some small, every square yard of the intermediate space between the bunds being richly cultivated, while the surrounding country appeared to be condemned to nearly perennial sterility. I believe that almost the whole rice crop of Mysore is derived from irrigation.

"This vast supply of water is gained partly by the method of tanks just described, and partly by tapping the Cauvery and other rivers, by means of subaqueous dams built during the dry season diagonally across the bed of the stream. The effect of these dams is to direct a portion of the river into lateral trenches, stretching far and wide over the country. From these it is again drawn off to water the rice fields. I remember hearing a traveller describe the mode in which the great river Indus is tapped or drawn off in this manner to the right and left for the purpose of agriculture, till the unhappy stream is fairly exhausted and its channel left dry. One is so much accustomed to consider the mighty mass of waters, forming a river of any magnitude, as something beyond the power of man to control, that it requires good evidence to satisfy our incredulity on this point. But if the Indus, in the districts alluded to, resemble the Mississippi and many other streams flowing over extensive alluvial countries, there need be no difficulty in conceding such a transfer of the whole of its waters from the ordinary bed of the stream to the fields on either side; because rivers which traverse deltas almost invariably flow along the summits of ridges somewhat higher than the adjacent country. These ridges, it is true, are so wide and flat that their elevation at most places can scarcely be detected by the eye; but still the inclination of their sides is abundantly sufficient to admit of water draining away from, instead of flowing towards, the river.

"During the fierce struggles between the French and English in the south of India, the embankments of the Cauvery were frequently cut, and the whole country, in consequence, laid under water. To explain this, it must be mentioned that as rivers which run along deltas, or along ground nearly level, are liable to overflow their banks during the rainy season, it becomes necessary, in order to prevent the country being inundated, to raise walls or embankments to confine the streams. These, (which are called in Louisiana levées, in India bunds,) being raised a little higher than the surface of the river at its highest, confine the stream within proper limits. But, as the floods of each successive year bring down a prodigious mass of gravel and sand, the wear and tear of the mountains, fields, and forests, through which the tributary streams have passed, a certain portion of the largest and heaviest of these materials must subside, and remain at the bottom when the river reaches the low grounds, where its rate of motion is much diminished. This addition, though it be small in any one year, gradually raises the bed of the river. If this rise were not carefully met by a correspondent annual elevation of the artificial embankment, it is obvious that the water in the course of time would periodically flow over and submerge the country. The consequence of these alternate struggles between the waters trying to escape and man insisting upon confining them, has been to lift the whole body of the Cauvery in its passage across the Carnatic several feet above the highest level of the surrounding country. The power of deluging the surrounding country was therefore a very obvious, though a dreadful weapon, in the hands of whichever

party held possession of the banks during those formidable wars in which the French and English contended for the sovereignty of Hindoostan. In the long period of peaceful and secure repose which those regions have enjoyed since the contest has been terminated by the unquestioned supremacy of one party, the supply of water so curiously raised into the air has been appropriated exclusively to the irrigation of the country.

"In the upper lands of Mysore the peasants are dependent chiefly on their tanks for moisture, as the rains are uncertain in quantity, and transient in their effects. The stock of water collected in these numberless and extensive tanks or ponds, many of which well deserve the name of lakes, is capable of being distributed in the precise quantity and at the precise times required. I have been often amused at observing with what scrupulous care the persons appointed to distribute the water let it off from these magnificent reservoirs. The thirsty soil of the Mysore, parched and riven by heat, drinks up the fluid with a kind of relish,—a sort of animated enjoyment, at which I was never tired of looking.

"In describing things which lie so much out of the ordinary course of observation, one becomes sensible of the poverty of language. Thus, the word *tank* suggests to most people the idea of a common cistern attached to a dwelling-house and filled with rain-water from pipes along the roof. The word *pond*, again, recalls images of muddy water, draggled post-horses, rank weeds, and a combined fleet of ducks and geese engaged in common warfare against frogs and worms. To call the tanks of Mysore by the name of lakes would be nearer the mark, for many of them well deserve that appellation. The *Moota Talou*, for example, or *Rich Tank*, near Seringapatam, I understand, is nearly thirty miles in circumference. I never saw that particular sheet of water, but many of the artificial lakes which I did examine measured six, eight, and ten miles round; and so vast are their numbers, that I remember counting considerably more than 100 at one view from the top of Nundydroog; nor do I believe that the least of these could have been less than two or three miles in circuit.

"Dr. Buchanan, in his journey through those countries, made by order of Lord Wellesley, in 1800, shortly after the capture of Seringapatam, describes minutely the formation of these tanks, or *Erays*, as they are called in the Tamul language. The *Saymbrumbacum Tank*, not far from Madras, he says, is eight miles in length by three in width, and its contents are sufficient to supply with water the lands of thirty-two villages for eighteen months, supposing the usual rains to fail."—*Hall's Fragments of Voyages*, pp. 88—108, vol. iii. 3d series.

(1040.) Rice is imported into England in large quantities, both from the East Indies and America. The Carolina rice is said to be the produce of one small bag, given as a present, by Dubois, the treasurer of the East India Company, to a Carolina trader; and in 1698 sixty tons were sent home. Upwards of one hundred thousand bags of rice are now annually imported, and the quantity is gradually increasing.

(1041.) The Canada rice, *Zizania fluitans*, although not yet much cultivated, has all the natural capabilities to become a valuable corn. Its grains are large, and replete with a fine bland

farina. It grows abundantly in the shallow waters of North America, and has been acclimated here; it grows freely both in Middlesex and Rosshire. Attempts are being made, which it is to be hoped will be successful, to cultivate it in Ireland. Pinkerton says, "this plant seems to be designed by nature to become the breadcorn of the North."

(1042.) Bambusaceæ. The Bamboo, and other arborescent grasses, are distinguished from the associated types not only by their port, but also by "their paniculate locustæ being many-flowered, their stamina six, and style single."

(1043.) *Bambusa*, the name of the normal genus, has been formed from the Indian *Bambos*. The tree-like size of these plants associates them in some measure with palms. They are applied, in China, India, and Japan, to a great number of useful purposes: sections of the small ones are made into cups, and of the larger ones into tubs and boxes; water-pipes are often made of them; and they are used in the construction of fences, building houses and boats, and making various articles of furniture. The tender tops of the young shoots form a favourite West India pickle. Perhaps the best idea, though still a faint one, of the beauty and magnificence of these arborescent grasses, may be given to the untravelled naturalist, by quoting Capt. Basil Hall's account of the impression a first view produced on him. He says,

"Early in the morning, of a beautiful day in the latter end of September, I set out from the bare table-land of Mysore, and proceeded towards the hilly and thickly-wooded regions overhanging the Malabar country. When I awoke in my palankeen, I knew not very distinctly where I had got to, for I had been dreaming all night about the monstrous statue at Shrivaabalagol. I sat up, drew the door gently back, and, looking out, found myself in the midst of one of the most curious and magnificent scenes which my eyes had ever beheld. It appeared as if I were travelling among the clustered columns of some enormous and enchanted Gothic cathedral, compared to which the minster at York, or the cathedral at Winchester, would have seemed mere baby-houses; the ground extended on all sides as smooth and flat, and clear of underwood, as if the whole had been paved with grave-stones. From this level surface rose on every hand, and as far as the eye could penetrate into the forest, immense symmetrical clusters of bamboo, varying in diameter at their base from six feet to twenty or thirty; and even to twice that width, as I ascertained by actual measurement. For about eight or ten feet from the ground, each of these clusters or columns preserved a form nearly cylindrical, after which they began gradually to swell outwards, each bamboo assuming for itself a graceful curve, and rising to the height, some of sixty, some of eighty, and some even of one hundred feet in the air, the extreme end being at times horizontal, or even drooping gently over, like the tips of the feathers in the Prince of Wales's plume. These gorgeous clusters stood at the

distance of fifteen or twenty yards from one another, and, being totally free from the interruption of brushwood, could be distinguished at a great distance—more than a mile certainly, in every direction, forming, under the influence of an active imagination, naves and transepts, aisles and choirs, such as none but a Gothic architect ever dared to conceive. Overhead the interlacing curves of the bamboos constituted as complete a groined roof as that of Winchester or Westminster, on a scale of grandeur far beyond the bold conception even of those wonderful artists who devised that glorious school of architecture, which, in the opinion of many people, has raised the dark centuries immediately subsequent to the era of the crusades, almost to the level of the days of Pericles.

"On counting the separate bamboos in some of the smallest, and also in some of the largest clusters, I found the numbers to vary from twenty to thirty to upwards of two hundred, and the height generally from sixty to a hundred feet from the ground, to the point of intersection of the curves overhead. Most of the bamboos were somewhat thicker than a man's thigh at the ground, where, as I have before said, they are clustered so close as to be almost in contact. They then taper off very gradually to the extreme end, where the point is not thicker than a quill.

"There occurs a joint at about every foot and a half, distinguished not only by a slight flat ring or fillet, but by a set of small branches, eight or ten feet long, striking out at right angles to the main bamboo. These minor shoots are again divided into joints, from which other series of shoots, still more minute, are thrown out; and so on for many successions, the last always terminating in a sharp pointed-narrow leaf, two or three inches long and half an inch wide in the middle, not unlike a large tea leaf when spread out. As each bamboo, of the hundred or more forming the cluster, sends out shoots from every joint, and as all the joints of these subordinate plants do the same, a compact mass is formed by these innumerable little branches, which cross one another at every possible angle. If a person were to fill a hat full of pins and needles, and shake it about for some minutes, it might give a notion of the inextricable confusion which is presented to the eye on looking into one of these clustered columns of bamboos. It is only at the top, where the bend takes place, that the foliage has full room to play, or where the tapering arms of this magnificent plant form, by their meetings and crossings, a complete system of pointed arches.

"What surprised me very much, and greatly puzzled me at first, was, to observe that, notwithstanding the multitude of lateral shoots from each of the main bamboos, and from all the subordinate branches, not a single trace of displacement, or the slightest obstruction to the growth of any branch, could be detected. Every person must have heard of the astonishing rapidity of the growth of the bamboo; it is said indeed that in one season it starts up to its whole length. I do not know if this be true, but am quite certain that if one of the main bamboos were to spring from the ground in the centre, or even near the sides of the cluster, and that from its joints there were at the same time to sprout out the lateral branches I have described, it would be impossible for the main stem to force its way through the obstructions presented by the network, formed by the little branches growing from the joints of the other bamboos in the cluster.

"After examining a considerable number of the clusters, however, we can, I think, perceive how nature manages this difficult affair. When the bamboo first

springs out of the ground it is about as thick as a man's wrist, but it is armed with a very sharp point, not unlike that of a wooden instrument called a fid, which sailors make use of in splicing ropes; as this point is extremely hard, and the bamboo always highly polished, it readily makes its way through the very thickest masses of the little branches, as one might thrust a sword through a quickset hedge. Thus the bamboo, whose growth is prodigiously rapid, starts upwards, and by reason of its smooth sharp end, and perfectly-smooth sides, easily makes its way to its extreme length and thickness, without, as I conceive, sending out a single lateral shoot from any of its joints, till the utmost extent has been gained. The subordinate branches from the joints then, but not till then, begin to start out horizontally, all these being, after the manner of the principal stem, exempted from lateral shoots at their joints till their utmost length has been reached. In consequence of this beautiful arrangement, none of these successive branches, however numerous or delicate, find any difficulty in piercing the confusion.

"I saw bamboos in every different stage of this process, and in particular I noticed several of the main stems rising to the height of seventy feet and upwards, of a clear yellow colour, and evidently of recent growth, but without a single lateral branch growing from their joints from top to bottom; and this led me to infer that their extreme height had not yet been reached, or was but just attained."

(1044.) The *Bambusaceæ*, *Oryzaceæ*, *Stipaceæ*, *Agrostidaceæ*, *Avenaceæ*, and *Phalaridaceæ*, are associated to form the section Festucinæ. They are arborescent or herbaceous grasses, with paniculate inflorescence; and the imperfect florets for the most part the upper ones of each locusta. This last-named character will at once distinguish the four types last mentioned from any of the *Panicinæ;* and they are the only ones likely to be confounded.

(1045.) *Zea*, *Coix*, *Lygeum*, and several other genera, the affinities of which are doubtful, are placed by Bartling in an appendix to the order. Further examination will probably attach some of these to the foregoing types; and Zea, Coix, &c. seem to afford materials for constructing another group.

(1046.) *Zea Mays* is the well-known Indian corn, which, although indigenous to warmer countries than our own, will thrive in favourable situations here. The crops, however, are uncertain, and the bread made from Mays flour is so inferior to wheaten, that little temptation exists to continue its culture here. In the Old world it is comparatively little grown, but in the Western hemisphere it rises into great agricultural importance.

Maize, like other corn, is capable of affording an inebriating liquor; and, as an example of the desire that prevails among all people, as well savage as civilized, to possess the power of intoxicating themselves, it may be mentioned, that with some Indian tribes, after the gathering in of their harvest, for the want of other mills and means, it is customary to give each of the old squaws a quantity of grain to chew, and a calabash to receive the triturated corn when reduced to the

form of paste. The contents of the calabashes are subsequently mixed, and water being added, the whole is left to ferment, and a sort of beer or wine is thus produced, of which they are very fond, and which they are prone to drink to excess.

The *Zea Curagua*, or cross-corn, is regarded with a kind of superstitious veneration in Valparaiso, from the grains, when roasted, splitting regularly into the form of a cross.

(1047.) The three sections, *Festucinæ*, *Panicinæ*, and *Triticinæ*, are associated to form the order GRAMINALES, or POALES, the characters of which have been already given, [§ 997;] and the two orders, GRAMINALES, and CYPERALES, are the only ones included in the class GRAMINA, or Grassedges, the Glumaceæ of some, the Culmiferæ of other writers. The grasses differentially considered are *glumose flowering plants, with endogenous stems and monocotyledonous or one-lobed seeds.*

(1048.) Collectively described, they are tubivascular herbaceous plants, rarely shrubby or arborescent; roots either annual or perennial; rhizomata endogenous; culms for the most part simple, though sometimes branched, and either round or angular, jointed or knotless, solid or hollow. The leaves are simple, alternate, entire with linear veins; leaf-stalks vaginate; inflorescence spicate, racemose or paniculate; flowers arranged in locustæ or spikelets, the valves of the perianth often imperfect or absent; stamens, for the most part three, or some multiple of three; filaments free; anthers two-celled; germen free; styles two or three, often connate; fruit a caryopsis or achenium; seed erect; albumen farinaceous, and of the shape of the fruit; embryo at the base of the seed, either within or without the perisperm, and imparilobed: the cotyledon being single, or when two are developed, they are alternate, not opposite to each other.

(1049.) *Tabular Conspectus of the Gramina, or Grassedges.*

Class.	Orders.	Sections.	Types.
GRAMINA. (1047 and 1048)	GRAMINALES or POALES. (998)	Festucinæ (1044)	*Bambusaceæ* (1042)
			Oryzaceæ (1038)
			Stipaceæ (1036)
			Agrostidaceæ (1034)
			Avenaceæ (1027)
			Phalaridaceæ (1025)
		Panicinæ (1023)	*Saccharaceæ* (1020)
			Miliaceæ (1018)
		Triticinæ (1016)	*Spartinaceæ* (1014)
			Hordeaceæ (1006)
	CYPERALES or (984) CALAMARIÆ.	Caricinæ (994)	*Caricaceæ* (995)
		Cyperinæ	*Scirpaceæ* (991)
			Papyraceæ. (993)

(1050.) To the grasses thus defined it has been occasionally proposed to add various small groups of grass-like plants, such as the reed-mace and the bur-reed (*Typhaceæ*), the true rushes (*Juncaceæ*), and the cord-rushes or rope-grasses (*Restiaceæ*, § 1100, et seq.): but although their affinity to the grasses and sedges is obvious, their relationship to the *Liliales* of the following class, *Palmares*, seems to be nearer and more decided. Thus, without the bur-reeds (*Spargania*), which are herbaceous allies of the screw-pine (*Pandanus*), can be excluded from the *Typhaceæ;* the subglumaceous rushes shewn to have less similitude to lilies than to grasses; and the *Xyridaceæ* proved not to be intimately allied to the *Restiaceæ* and *Ephemeraceæ*, as well as more remotely to *Orchidaceæ;* neither of them can, consistently with a due regard to their natural affinities, be severed from the Palmares and attached to the Gramina; and this, the more especially as their floral envelopes when present are not *glumes*, but *perianths*, [vide § 1076], and although often husk-like are frequently sub-petaloid, and sometimes even decidedly corollate.

(1051.) Whether these osculant groups are located among the *Palmares*, or subjoined to the Gramina, is not, however, a point of very great importance. They are confessedly transitional from the one class to the other, and should the glumaceous texture of the flower coverings be esteemed an associating character of more importance than the alternate disposition of the valves in glumes, and their whorled arrangement in perianths, the above-named groups, or some of them, may form an additional order of the present class called the JUNCALES, or TYPHALES.

(1052.) Allusion has several times been made to the vast importance of the grasses as a source of food, both direct and indirect, to brute animals and man. But perhaps a bare statistical account of the quantity of corn consumed in one nation, in a given time, may afford a better idea of the importance of the cereal grasses to man, than any more lengthened commendation; and perhaps our own country, although here less vegetable food is eaten than in many other nations, (the French averaging each person ten bushels a year to our one quarter,) may still afford the best practical examples.

From a laborious series of investigations, Mr. M'Culloch has computed that the average daily consumption of corn in the United Kingdom amounts to 154,762 quarters; *i. e.* 1,238,096 bushels are either devoured or otherwise used by man, to minister directly or indirectly to his necessities every day in this comparatively minute spot of earth. One week's consumption, the same eminent authority informs us, is 1,083,333 quarters, or 4,333,232 combs, or 8,666,664 bushels; and the yearly consumption 52,000,000 quarters, or 416,000,000

bushels; and to this should be added 100,000 bags of rice, besides 200,000 tons, or nearly 450 million pounds of sugar.

(1053.) But in order, however, fairly to estimate the value of the grasses to man, a report should also be attempted of the quantity consumed as pasturage, a great proportion of which becomes indirectly human food, when converted into milk, butter, cheese, mutton, beef, and veal, and still more is rendered subservient to our comfort as the support of the beasts of burden that labour for the benefit of man. On several of these points, however, the means of calculation are too imperfect to allow any general statement to be adventured, still on one, viz. the grass that men indirectly eat, the same political economist will enable us to form some notion; for we learn that the average yearly consumption of butcher's meat, by every individual, young and old, amounts to nearly one hundred weight: it has indeed been estimated at more than double this, exclusive of fish and poultry; and statistical accounts declare that, not computing pork, bacon, or poultry, the population of London alone annually consumes 154,434,850 pounds of meat.

(1054.) It has been estimated that a horse requires for its support as much land as would on an average raise sufficient food for eight men; now there are in Great Britain upwards of a million of horses engaged in various ways, in the transport of passengers and goods, all of which are supported chiefly, if not entirely, upon the grasses. But again: the stock of cattle in England averages nearly 3,000,000, that in Scotland upwards of 1,000,000; together, in round numbers, 5,000,000. In France it is stated to be 6,681,000, in Prussia 4,355,000, in the German Confederation 12,000,000. The stock of sheep in England, four years ago, was estimated at 25,000,000, and in Scotland 5,000,000, being 30,000,000 in Great Britain alone, exclusive of Ireland; and of these, it is said, that 33,000 sheep and lambs are slaughtered weekly in Smithfield only, *i.e.* from 1,250,000 to 1,500,000 per annum. Add to the foregoing the immensity of cheese produced; Cheshire, it is calculated, affords about 11,500 tons a year, Warwickshire sends annually about 20,000 tons to London, besides a large quantity to Birmingham and other places; and, although an estimate cannot be made of the entire quantity produced or consumed either in the metropolis or in the country, Dr. Colquhoun states, that the value of butter and cheese consumed in the United Kingdom must be worth at least 5,000,000*l.* a year, exclusive of the milk from which they are made.

This sum, as M'Culloch says, is perhaps too high, but there are not data sufficient at command either to correct or verify it; and from supplies produced in single counties, we are assured it must be very great: for it is known that fifty million pounds of butter are annually brought into this great city; which, at the average production of 168lbs. per annum, will require 280,000 cows to be kept for the supply of the London market only; exclusive of those that must afford the same article of food to the other parts of the kingdom, and exclusive of those which must be kept to yield the ordinary supply of milk, of which a very faint notion can be given, for so much less milk is drank in London than in the country, and by fraud the London milk is so much increased in measure, that the 9000 and upwards of milch cows which are kept in the environs, are not a fair proportion of what are kept for the supply of milk in other places. Now each cow on an average yields nine quarts of milk a day; hence 81,000 quarts of pure milk are consumed in the metropolis daily, *i.e.* thirty million quarts per annum. As the grasses are known to be the chief support of the animals whence such enormous supplies of human food are drawn, they are indirectly, no less than directly, the

staple sustenance of man; and when traced to their source, the various articles above named, of which a sample rather than a catalogue has been given, can scarcely be esteemed other than grasses in disguise.

GEOGRAPHICAL DISTRIBUTION OF THE GRAMINA.

(1055.) As affording their chief food both to men and animals, no plants are more important than the grasses, and hence there are no plants that are more universally distributed over the surface of the globe, or that have been more varied, to adapt them to the varied circumstances of the countries in which they grow. Certain plants are confined to certain places, and others of still greater range are restrained within certain latitudes, but grasses extend from the equator almost to the poles. In the frigid zone, barley, oats, and lyme-grass flourish, and are cultivated as bread-corn in Lapland as far north as the seventieth degree; and even Spitzbergen is not destitute of grass. In more temperate regions rye is added to the list of cultivated corn; but in England, France, and Germany, wheat becomes the staple food of man, while barley, oats, and rye are chiefly cultivated as provender for horses, for brewing, or for the use of the distillery. In Spain, Portugal, Italy, and Greece, maize is added to the more northern corns, and in hot swampy districts rice; where rye and oats are seldom seen, and in some parts unknown, and where barley becomes the food of the beasts of burden.

(1056.) In many places other flowering Monocotyledons, such as the palms and the bananas, with a few Dicotyledons, as the batatas, the manihot, and the bread-fruit, in a great measure supply the place of cereal grasses, or entirely supersede the use of corn. But these are exceptions to the general rule; and hence the grasses are of more importance both in a commercial and political point of view, as well as in the general economy of nature, than any other vegetables known. In most countries they form the principal part of the external covering of the earth; and, in respect to ornament, they play a very prominent part, giving to the plains and hills their lovely green, and bordering the blue waters of the lake and the meandering course of the rivulet, or the majestic windings of the mighty stream. They also restrain the degradation of upland and hilly grounds, fix loose sands, and prevent deluges more fatal than watery floods. They materially affect the atmosphere, especially its quantity of moisture. They support a whole world of insects, and afford the chief nourishment of domestic animals. They are on this account of the utmost consideration in the breeding of cattle; and, since the most important of the cultivated plants belong to them, they constitute likewise the basis of agriculture, one of the breasts of the state. But the rearing of cattle and of corn is not only the main support of nations; it determines the degree of culture and mode of life, and, to a certain extent also, the manners and customs of particular people. The geographical relations of the Gramina must therefore be interesting, not merely to the botanist, but to those who occupy themselves with the sciences relating to man, and the policy of nations.

(1057.) The pasture grasses and the sedges are less numerous in tropical than in extra-tropical regions; they grow to a larger size, becoming arborescent, and less fit for food. They also, from their magnitude, are more distant from each other, and do not form the compact continuous turf which characterizes the verdant fields of temperate latitudes. A final cause for these variations may be found in the acknowledged tendency that such a disposition has to promote the health of man, for in hot climates, where much animal food would be injurious, the pas-

cual grasses on which flocks and herds are fed, are less abundant than in the temperate latitudes, where flesh in larger quantities is required for human food.

(1058.) Of the two orders into which the grasses have been divided, the Graminales extend further towards the equator than the Cyperales, which are in the greatest relative proportion in northern latitudes. Thus, in Lapland, notwithstanding the very different extent of the two orders, the sedges are equal in number to the true grasses; but if traced thence to the line, the relative proportion is very much reduced. The several types which prevail are also changed. Northwards the *Caricinæ* and *Scirpaceæ* are predominant, while towards the equator the paper-reed and other *Papyraceæ*, are chiefly found, which here are either rare or totally unknown.

(1059.) Thus, from the calculations of Humboldt, and others, it appears that *Cyperales* form but $\frac{1}{57}$ of the flowering plants in tropical America, $\frac{1}{25}$ in India; and $\frac{1}{18}$ in Western Africa, and $\frac{1}{14}$ in New Holland. On an average they amount to about $\frac{1}{20}$ in the temperate regions; being in Sicily $\frac{1}{57}$, France $\frac{1}{27}$, Germany $\frac{1}{18}$, Denmark $\frac{1}{16}$, and Sweden about $\frac{1}{12}$: in the frigid zone, *i. e.* in Lapland and Kamtschatka, their proportion is about $\frac{1}{9}$, in Melville Island $\frac{1}{17}$.

(1060.) From similar calculations, the general distribution of the grasses would seem to vary in about the following proportions. Within the tropics rather more than $\frac{1}{15}$, in the temperate regions $\frac{1}{13}$, in the frigid zone $\frac{1}{10}$: in Melville Island almost $\frac{1}{5}$.

Again: of the nearly 2000 known species about 800 are tropical, and from 1150 to 1200 are extra-tropical.

(1061.) Of the various subordinate types and sections not one is confined exclusively to either zone, although some genera and many species are local. But the relatively greater proportion of the *Bambusaceæ*, *Saccharaceæ*, *Miliaceæ*, and *Spartinaceæ*, within the tropics, justifies their enumeration as tropical groups, while the *Agrostidaceæ*, *Avenaceæ*, and *Hordeaceæ*, for the contrary reason, may be esteemed extra-tropical. The *Oryzaceæ* and *Stipaceæ*, are pretty equally divided, the former being rather a tropical, and the latter an extra-tropical type.

(1062.) The distribution as to altitude, is nearly consonant with that as to latitude, the *Miliaceæ* and *Saccharaceæ* predominating on the lower, the *Avenaceæ* and *Agrostidaceæ* on the higher elevations. Thus, above 9,600 feet, the *Avenaceæ* are to the *Miliaceæ* as 8 : 1; but below 1200 feet, only as 7 : 39. Some local exceptions, however, are known to this general law. In Southern Europe, for example, the grasses, seem to diminish instead of to increase, according to the elevation, for in the Alpine Flora their relative proportion is only $\frac{1}{18}$, while it is $\frac{1}{12}$, or $\frac{1}{14}$ on the plains.

(1063.) A considerable difference has been shewn to prevail in the distribution of the types, but "between the genera the contrast is naturally greater, and manifests itself not only according to the latitude, but also the longitude. Thus, in the torrid zone, the genus Paspalus has a decided preponderance in the New World. Most of the genera, however, especially the larger, for example, Panicum, Andropogon, and Chloris, are everywhere nearly equal, those that are peculiar being generally not at all numerous. The generic difference between North America and the temperate regions of the European continent is very small. In North America, however, a greater number of tropical forms appears. Between the two temperate zones also the distinction seems to be by no means considerable. Of thirty-six genera from the Cape, thirty occur in the temperate zone of the northern hemisphere, while in other families, Southern Africa has many peculiar

to itself. In the extra-tropical part of New Holland, the greater number of genera is found also in the north (about two-thirds); and this appears to be still more the case in the southern parts of South America, as well as New Zealand. One of the most extensively distributed genera is Poa. It is found almost over the whole earth; and, although it reaches its maximum in the temperate, has also many species in the torrid zone. A tendency to a wider distribution in the family of the grasses, is found, not only in the groups and genera, but also in the species. Among many examples, we particularize only *Lappago racemosa*, which occurs in the south of Europe, in Arabia, in both Indies, and in South America; *Cenchrus echinatus*, *Festuca myurus*, *Poa megastachya*, *Andropogon allionii*, *Holcus halepensis*, in the highlands of South America, and in Europe; *Panicum crus-galli*, *P. glaucum*, *Cynodon dactylon*, *Holcus gryllus*, *Arundo Phragmites*, and *Festuca fluitans*, in Europe and New Holland; *Paspalus vaginatus*, in Tranquebar, Jamaica, and the Isle of France; *P. filiformis*, in India, Jamaica, and North America; *Rottbollia dimidiala*, in Guinea, at the Cape, and in Jamaica; and *Imperata arundinacea*, on the Mediterranean, in India, and New Holland.

What has been said of the decided influence of the degrees of latitude on groups and genera, holds also of the habitus of vegetation in general. The greatest differences between tropical and extra-tropical grasses appear to be the following.

"1. The tropical grasses acquire a much greater height, and occasionally assume the appearance of trees. Some species of Bambusa are from fifty to sixty feet high [1043], and upwards.

"2. The leaves of the tropical grasses are broader, and approach more in form to those of the other families of plants. Of this Paspalus affords many examples.

"3. Separated flowers are more frequent in the tropical grasses. Zea, Sorghum, Andropogon, Olyra, Anthistiria, Ischæmum, Ægilops, and many other genera, which only occur in the torrid zone, and are there found in perfection, are monœcious or polygamous. Holcus is perhaps the only extra-tropical genus, with separate flowers.

"4. The flowers are softer, more downy, and elegant [§ 71].

"5. The extra-tropical grasses, on the contrary, far surpass the tropical in respect of the number of individuals. That compact grassy turf, which, especially in the colder parts of the temperate zones, in spring and summer, composes the green meadows and pastures, is almost entirely wanting in the torrid zone. The grasses there do not grow crowded together, but, like other plants, more dispersed. Already, in the southern parts of Europe, the assimilation to the warmer regions, in this respect, is by no means inconsiderable. Arundo Donax, by its height, reminds us of the Bamboo; Saccharum Ravennæ, S. Teneriffæ, Imperata arundinacea, Lagurus ovatus, Lygeum spartum, and the species of Stipa, by their soft, downy, elegant flowers; and the species of Andropogon, Ægilops, &c. by separate flowers, exhibit tropical qualities. The grasses are also less gregarious, and meadows seldomer occur in the south than in the north of Europe.

As to what relates to the distribution of individuals, the generality of species are social plants.

(1064.) "Lastly. Do we wish to know how this family is distributed, in respect of the number of species, and where they reach their maxima and minima? The following materials may supply, not indeed either a complete or faithful representation, because the grasses are not treated of by botanists or travellers in

general with the same care as the other families, but they will at least give some hints towards effecting that object. In Persoon's Synopsis, the grasses of the torrid zone form $\frac{1}{23}$, and those of the temperate zone $\frac{1}{22}$ of the whole vegetation; but, when it is considered that the grasses of the former have been less investigated than the European, the quotient would be nearly alike in both zones. In the systems of Ræmer and Schultes, tropical are to the European grasses as two to three; but this, from a probable conjecture, is also the proportion of all tropical and extra-tropical plants. In Persoon's Synopsis it is one to two; and, since the publication of that work, the knowledge of the tropical has been enlarged in a greater proportion than that of the extra-tropical plants. Although, however, the quotients in the torrid and temperate zones may be nearly equal upon the whole, when taken in subdivisions there will be an inequality. In the warm regions of South America, the grasses under 200 toises elevation, form from $\frac{1}{13}$ to $\frac{1}{16}$ of the whole; in the West Indies $\frac{1}{17}$; on the river Essequibo, in Zugana, $\frac{1}{12}$ to $\frac{1}{15}$; on the river Congo $\frac{1}{12}$ to $\frac{1}{13}$; in Guyana $\frac{1}{10}$; (in the last three the local circumstances are peculiarly favorable for the grasses;) in the East Indies, according to Brown, $\frac{1}{12}$; in Arabia $\frac{1}{1}$; and in tropical New Holland $\frac{1}{10}$ to $\frac{1}{11}$. Now, attending to the circumstance that tropical are scarcely so well known as other phanerogamic plants, it is not improbable that the true quotient for the torrid zone is $\frac{1}{10}$ to $\frac{1}{12}$. In the warmer parts of the temperate zone the grasses appear to form a smaller proportion of the vegetation; for, in the extra-tropical parts of New Holland they form from $\frac{1}{24}$ to $\frac{1}{25}$, at the Cape $\frac{1}{35}$, in Greece $\frac{1}{15}$ to $\frac{1}{16}$, in the Canary Islands $\frac{1}{12}$ to $\frac{1}{13}$, in the Crimea and Caucasus $\frac{1}{14}$ to $\frac{1}{15}$, in Naples $\frac{1}{11}$ to $\frac{1}{12}$, in France $\frac{1}{13}$, and in Egypt (where, however, the circumstances are peculiarly favorable,) $\frac{1}{8}$. Farther north the relative numbers seem to rise somewhat higher; in Germany $\frac{1}{13}$, in Great Britain $\frac{1}{11}$ to $\frac{1}{12}$, in Denmark $\frac{1}{10}$ to $\frac{1}{11}$, in Scandinavia $\frac{1}{10}$ to $\frac{1}{11}$, in Kamschatka $\frac{1}{7}$ to $\frac{1}{8}$, Lapland $\frac{1}{10}$, Iceland $\frac{1}{8}$ to $\frac{1}{9}$, Greenland $\frac{1}{8}$ to $\frac{1}{9}$, and in North America, according to Pursh, $\frac{1}{14}$ to $\frac{1}{15}$. We may assume, perhaps, as a medium for the warmer parts of the temperate zone, $\frac{1}{12}$ to $\frac{1}{14}$; for the colder, together with the polar regions, $\frac{1}{8}$ to $\frac{1}{10}$. That almost in every flora the quotient is considerably higher than in the works of Persoon, and of Ræmer, and Schultes, affords another proof that, in the rule, the distribution of the grasses is more extensive than that of the other phanerogamic plants. In Southern Europe the number of the grasses seems to diminish according to the elevation, for in the Alpine Flora they are only $\frac{1}{18}$. Their distribution according to elevation does not, therefore, agree with that acording to the latitude; in South America the agreement is greater, for the relative numbers are 0 to 200 toises, $\frac{1}{15}$ to $\frac{1}{16}$; 200 to 1100 toises, $\frac{1}{15}$ to $\frac{1}{16}$; 1100 to 1600 toises, $\frac{1}{11}$; above 1600 toises, $\frac{1}{14}$."

(1065.) A detailed representation of the distribution of the cultivated Gramina would certainly be very interesting. Here we must restrict ourselves to a short general outline. We shall endeavour to specify those Gramina which are the prevailing ones in the large zones and continents, mentioning, in passing, those plants of other families which either supply the place of, or are associated with, the different kinds of grain, as the chief articles of food. This distribution is determined, not merely by climate, but depends on the civilization, industry, and traffic of the people, and often on historical events.

" Within the northern polar circle, agriculture is found only in a few places. In Siberia, grain reaches at the utmost only to 60°; in the eastern parts, scarcely

above 55°; and in Kamschatka there is no agriculture, even in the most southern parts (51°.) The polar limit of agriculture on the north-west coast of America appears to be somewhat higher; for, in the more southern Russian possessions, (57° to 58°,) barley and rye come to maturity. On the eastern coast of America it is scarcely above 50° to 52°. Only in Europe, namely Lapland, does the polar limit reach an unusually high latitude, (70°.) Beyond this, dried fish, and here and there potatoes, supply the place of grain. The grains which extend farthest to the north of Europe are barley and oats. These, which in the milder climates are not used for bread, afford to the inhabitants of the northern parts of Norway and Sweden, of a part of Siberia and Scotland, their chief vegetable nourishment.

"Rye is the next which becomes associated with these. This is the prevailing grain in a great part of the northern temperate zone, namely, on the south of Sweden and Norway, Denmark, and in all the lands bordering on the Baltic, the north of Germany, and part of Siberia. In the latter, another very nutritious grain, buck-wheat, is very frequently cultivated. In the zone where rye prevails wheat is also generally to be found, barley being here chiefly cultivated for the manufacture of beer, and oats supplying food for horses.

"To these there follows a zone in Europe and Western Asia, where rye lessens, or disappears, and wheat almost exclusively furnishes bread. The middle or the south of France, England, part of Scotland, a part of Germany, Hungary, the Crimea, and Caucasus, as also the lands of Middle Asia, where agriculture is followed, belong to this zone. Here the vine is also found; wine supplants the use of beer, and barley is consequently less raised.

"Next comes a district where wheat still abounds, but no longer exclusively furnishes bread; rice and maize becoming frequent. To this zone belong Portugal, Spain, part of France on the Mediterranean, Italy, and Greece; further, the countries of the East, Persia, Northern India, Arabia, Egypt, Nubia, Barbary, and the Canary Islands; in these latter countries, however, the culture of maize or rice, towards the south, is always more considerable; and in some of them several kinds of Sorghum (Doura), and Poa Abyssinica, come to be added. In both these regions of wheat, rye only occurs at considerable elevations; oats, however, more seldom, and at last entirely disappear; barley affording food for horses and mules.

"In the eastern part of the temperate zone of the old continent, in China, and Japan, our northern kinds of grain are very unfrequent, and rice is found to predominate. The cause of this difference between the east and the west of the old continent appears to be in the manners and peculiarities of the people. In North America, wheat and rye grow as in Europe, but more sparingly. Maize is more reared in the western than in the old world; and rice predominates in the southern provinces of the United States.

"In the torrid zone, maize predominates in America, rice in Asia, and both these grains in nearly equal quantity in Africa. The cause of this distribution is, without doubt, historical; for Asia is the native country of rice, and America of maize. In some situations, especially in the neighbourhood of the tropics, wheat is also met with, but always subordinate to other kinds of grain. Besides rice and maize, there are in the torrid zone several kinds of grain, as well as other plants, which supply the inhabitants with food, either used along with them, or

entirely occupying their place. Such are, in the new continent, Yams (Dioscorea alata), the Manihot (Jatropha manihot), and the Batatas (Convolvulus batatas,) the root of which, and the fruit of the Pisang (Bananæ, Musæ sp), furnish universal articles of food. In the same zone in Africa, Doura (Sorghum,) Pisang, Manihot, Yams and Arachis hypogæa. In the East Indies, and on the Indian Islands, Eleusine coracana, E. stricta, Panicum frumentaceum, several Palms and Cycadeæ, which produce the sago, Pisang, Yams, Batatas, and the bread-fruit (Artocarpus incisa.) In the islands of the South Sea grain of every kind disappears, its place being supplied by the bread-fruit tree, the Pisang, and Tacca pinnatifida. In the tropical parts of New Holland there is no agriculture, the inhabitants living on the sago of various palms, and some species of Arum.

In the highlands of South America there is a distribution similar to that of the degrees of latitude. Maize indeed grows to the height of 7,200 feet above the level of the sea, but only predominates between 3000 and 6000 of elevation. Below 3000 feet it is associated with the pisang and the above mentioned vegetables, while, from 6000 to 9260 feet, the European grains abound,—wheat in the lower regions, and rye and barley in the higher: along with which, *Chenopodium Quinoa*, as a nutritious plant, must be enumerated. Potatoes alone are cultivated from 9260 to 12,300 feet.

"To the south of the tropic of Capricorn, wherever agriculture is practised, considerable resemblance with the northern temperate zone may be observed. In the southern parts of Brazil, in Buenos Ayres, Chili, at the Cape of Good Hope, and in the temperate zone of New Holland, wheat predominates; barley, however, and rye, make their appearance in the southernmost parts of these countries and in Van Diemen's Land. In New Zealand the culture of wheat is said to have been tried with success; but the inhabitants avail themselves of the *Acrostichum furcatum*, as the main article of sustenance.

"Hence it appears that, in respect of the predominating kinds of grain, the earth may be divided into five grand divisions or kingdoms. The kingdom of rice, of maize, of wheat, of rye, and lastly, of barley and oats. The first three are the most extensive: the maize has the greatest range of temperature, but rice may be considered as supporting the largest number of the human race." (Abridged from Schouw's Grundzüge einer Allgemeinen Pflanzen-Geographie, in Jameson's Edinburgh Journal, April 1825.)

(1066.) The special topography of the grasses is no less interesting than their general distribution; but of their stations little remains to be said, as their chief localities have been already given when treating of the various types and sections. It must then have been observed, that, although there are both land and water-grasses, the aquatic gramina are none of them marine; and that, although occurring in every soil, sand is unfavorable to the growth of the majority; the maritime species, and those found in sabulous districts, being nearly peculiar to such situations. Some of them are social, some solitary plants, and amongst the former many are so gregarious and so intolerant of other plants, that they cover, to

the exclusion of most other vegetables, very extensive tracts of land. The bowling-green-like *pampas*, in the vicinity of Buenos Ayres, form a part of what is there called 'the region of grass,' several hundred miles in extent; and so abundant are herbaceous, and so scarce arborescent plants, that flocks are worth less than fuel, and horses of less value than the firewood they carry.

(1067.) As certain soils are alone affected by certain grasses, or at least are most favorable to their growth and increase, so these grasses, in their turn, become often indicative of the physical conditions of the places in which they abound: not only being more or less certain signs of the nature of the soil, whether chalk, or sand, or clay, but also of the healthiness or insalubrity of their several localities. Thus *Festuca ovina, Poa ovina, P. alpina*, and other viviparous grasses, are found most frequently, and in the greatest profusion, on exposed highlands, while the *Glyceriæ, Arundo Phragmites*, &c. as constantly abound in swampy districts. Hence the former, even when in lowland pastures, and not on elevated downs, are natural indications of a dry, and probably a healthy district; while the latter, on the contrary, even should the bogs have been dried up by the heat of summer, are as sure monitors of damp, and probably unhealthy places, where malaria exists, and where remittent and intermittent fevers are likely to prevail.

(1068.) The great importance of the grasses, and the extreme solicitude of nature for their preservation, is constantly apparent: not only is it seen in the constitutional peculiarities impressed on various tribes, to fit them for various latitudes and soils, but also in the compensating powers with which they are so wonderfully provided, that they are enabled to resist accidental injuries, and to overcome many external local disadvantages, that would seem, at first sight, to be insuperable. Thus, for example, the more the leaves of grasses are consumed and their flowering culms destroyed, the more they propagate themselves by offsets from their roots. Furthermore, graminivorous animals in general prefer the foliage to the culms, which thus are often left to ripen their seeds: or even, if trodden down, they are not destroyed, for roots are protruded from the nodi; and the plants in pastures are thus inconceivably multiplied by layers. On exposed downs and alpine grass-lands, where the heat is often insufficient to ripen the seeds, or if ripened, where the winds would bear them away from the mountain-sides, few are found to flower; but, as before observed, the viviparous

species and varieties prevail. The final cause of this arrangement would seem to be twofold, although both are so mutually dependent that they are separable only in idea. In the first place, to insure the preservation and propagation of the plants themselves, which are to form pastures and to afford food for the chamois and the mountain-sheep and goat; and, in the second, to keep the vegetable mould, essential for their own subsistence, from being blown by winds, or washed by torrents from the shelving hills into the vales below. This is done by the wide-spreading roots and subterranean suckers of these alpine grasses, the necessary consequence of the abortion of their seeds and their viviparous multiplication: for a living network is thus produced by their interwoven ramifications which encompasses the hills, and covers their sloping sides, with-holding the earth as within a web, thus restraining their degradation; and hence being, although primarily reproductive, no less important in their secondary conservative design.

(1069.) The sand-grasses, and sand-sedges, so abundant on our sea-coasts, are exposed to equal difficulties with their alpine associates, in the ripening their seeds, and the retention of them, when ripened, on the shore, for the constant winds that prevail would either carry them inland, or cast them into the sea. These grasses therefore increase also by their subterranean shoots; and an equivalent secondary service is likewise here fulfilled to that which is performed by the viviparous grasses of the highlands: for the vast banks of sand which are washed up by the sea upon many coasts, and which, when blown inland, deluge corn-fields and pasture-lands, converting fertile districts into deserts, are restrained as soon as the *Elymus arenarius*, the *Carex arenaria*, and their fellow-labourers, colonize these tracts. The long fibrous downy creeping roots fix the loose and flowing sands, which would otherwise advance with fatal sureness. Much land has been thus overwhelmed on the Biscayan shores: in Egypt vast tracts of fertile country have been thus converted into deserts: near Downham, in Suffolk, the sand-floods have encroached five miles within the last century; and in Scotland hundreds of acres have been utterly destroyed. The Coubin estate, near Fores, which once was worth 300*l.* per annum, has long been overwhelmed with sand. The fearful inundation in this neighbourhood was in 1769 so rapid in its encroachments that an apple-tree was buried by it during one season, so that only the very summit appeared. This

fatal flood was occasioned by recklessly pulling up the *bent-star* or *mat-grass*, when some trees were cut down. Strange as it must appear, notwithstanding such lamentable ravages, the country people destroy the sea-mat grasses, collecting them for fuel; thus removing their greatest protectors, the natural antagonists of moving sands. To such an extent were they at one time destroyed, that an act of Parliament was passed, rendering their destruction penal. (15 George II. c. 23.) Sand-banks when fixed by the mat-grasses become gradually covered by vegetable mould, and as the sea recedes they gradually migrate to the new formed shores, leaving the richer soil to other species, and fix succeeding banks as they are successively thrown up. The sand-hills on the French coast between Dunkirk and Boulogne, especially about Calais, are covered with these mat-grasses, which keep them firm, and the banks on our Flintshire shores, in the parish of Llanissa, are also similarly fortified. Stillingfleet recommended the sowing of mat-grass, which it is providentially ordained that cattle will not eat, on the sandy wilds of Norfolk, to restrain the deluges of sand to which that county is subject, and with much probability of success, for the Dutch owe the existence of no inconsiderable part of their country to the defensive power of the *murah* or *mat-grasses*, which they call *halm*.

Many other examples of the protecting powers of these plants might be adduced: let one more suffice for present illustration. As the ocean retires from certain shores, it encroaches upon others. The situation of the town of Hull is such, that, in the opinion of those conversant with the subject, it would long since have been washed away, and its site covered by the sea, were it not protected by Spurn-point, which receives the full force of the swell, and breaks its power before it reaches Hull. Spurn-point is a sandbank, at first fixed, and still preserved by the roots of mat-grass.

GEOLOGICAL CONSIDERATIONS.

(1070.) No fossil remains of grasses have hitherto been found in either the secondary or tertiary* formations. Negative evidence is thus adduced of their

* The fossil *Endogenæ*, called Endogenites, Culmites, Poacites, Cyperites, &c. are of very doubtful affinity. Two things only can be affirmed of them with safety, first, that they are the remains of Monocotyledonous plants, and, secondly, that they are not Gramina, or at least, that there is no satisfactory proof of their being such. The last named, which is the most like a fossil sedge of any yet discovered, is figured in Lindley and Hutton's Fossil Flora, pl. 43, fig. 1 and 2; see also the Fossil Palmares, in the following chapter.

absence from the ancient floras of the earth. This is a conclusion that could not have been guessed at; for grasses are now known to form a part, and a very considerable part, of the vegetation of every region of the globe. There are many that flourish directly under the line, and Agrostis algida grows even in Spitzbergen. As none of the grasses are marine, although there are many that are maritime, it was not to be expected that any vestiges should occur among the earliest relics of the Fucales. Even in the coal formation, where representatives of tropical Ferns abound, their absence might not be wholly unsuspected: for, previous to the creation of air-breathing animals, grasses were not required for pasturage, and therefore might be absent; but that there should be none discovered in the upper tertiary beds, where the fossil remains of huge herbivorous beasts are found, does seem extraordinary indeed. It must however be remembered, that some of the largest now existing are browsing, rather than grazing animals.

(1071.) The absence of grasses, from the deposits of epochs in which there flourished palms and pines, and the representatives of many of the so-called more perfect plants, confirms the objection already made to the doctrine of progressive development; and adds another proof to those which have previously been given, of its opposition to facts and to the warrant of experience.

(1072.) The duties which the primæval ferns appear to have performed in the general economy of nature, seem in some measure to explain the late advent of the grasses: for not only would plants, which draw greatly on the soil, have been as it were anachronisms, in an epoch when no vegetable mould was formed, but they would have impeded rather than have furthered the operations then in progress for the purification of the atmosphere, and the consolidation of its superabundant carbon.

(1073.) In the present era, however, the case is wholly changed. Now the myriads of generations of plants and animals that have lived and died, and added their substance to the soil, would be sad incumbrances on the face of this fair world, were there not means devised for rendering the matter they contain, and which is no longer useful to themselves, useful to their survivors. This is done by those plants especially which require rich soil and much manure for their support; and which thus, living on the dead, bring back to us again, in the form of fairest fruits and flowers, the refuse filth, and offal, that are cast upon the dung-heap.

Were it not for such natural transmutators; were matter once eaten, uneatable again; were it not that the present generation lives upon the past, as succeeding generations will live upon the present; were it not that the same atoms are digested over and over again, the whole earth might be in time devoured, and its inhabitants starve, amidst the wreck they had made.

Putrefaction and decay are generally regarded with disgust; and the admirable process of corruption too often turned from with horror. But dissolution is not destruction, and few secrets are more wonderful than those which such a change reveals: for it shews the first and the last of a series of extraordinary events, the earliest and the latest of those mysterious transformations that all organic beings undergo; and by which creatures, old, decrepid, and worn out, are, as it were by natural magic, converted into others young, vigorous, and strong. Thus nature is renewed, and death, so much dreaded as a destroyer, should rather be looked on as the renovator of the world.

OUTLINES OF PALMAROLOGIA.

(1074.) Palms and Lilies, the *princes* and *patricians* of the vegetable kingdom, as they were once figuratively called by Linnæus, form, with the Bananas and their immediate allies, an extensive group, to which the most noble individuals it contains have given the common collective name Palmares.

(1075.) This, which is the sixth class of the present ascending scale, includes all those grain-bearing or one-lobed flowering plants which are not furnished with glumes or husks, but which are either destitute of floral envelopes, or have them arranged in whorls.

(1076.) This disposition of the modified foliage is considered indicative of a higher grade of organization than exists in the sedges and the grasses; and the metamorphosed leaves are therefore no longer called *glumes* or *husks*, but *phylli*, and form, collectively, an organ named the *Empalement* by Grew, the *Perianth* or *Perigone* (Perianthium, perigonium,) by modern writers. But the phylli, besides being developed on the same plane instead of alternating with each other, exhibit a further remarkable change; for, in the vast majority of cases, a part, if not the whole of the Empalement, loses its comparatively coarse foliaceous texture and green hue, and becomes peculiarly delicate and variously coloured. When thus coloured it is said to be petalöid, when green, sepalöid; for, if distinguishable into a double series, the outer is called a *calyx*, and the inner a *corolla*, the modified leaves of the latter being termed petals, of the former, sepals: if not distinguishable into calyx and corolla, the common term, *empalement* or *perianth*, is used; and, if only a single series is evolved, that is called a *perigone*.

(1077.) The tendency which is obvious in all, and confirmed in most, of these plants to develop the floral coverings on the same plane or in whorls, and to convert the rude green *phylli* into a delicately coloured petal-like calyx or corolla, has caused the *Palmares* to be sometimes called *Petaloïd Endogenæ*, or *Monocotyledons;* but as several are destitute of perianth, and others are glumaceous, the term conveys a false impression, and is therefore untenable.

(1078.) The PALMS (*Palmæ*), the RUSHES (*Junci*), the LILIES (*Lilia*), and the BANANAS (*Musæ)*, give their names to the four orders that are associated to form this class, and which are hence called respectively the PALMALES, the JUNCALES, the LILIALES, and the MUSALES.

(1079.) The MUSALES appear to have fewer points of resemblance to the GRAMINA than either the JUNCALES, PALMALES, or LILIALES. Indeed, the close connexion of the latter with the CYPERALES through *Juncaceæ*, *Restiaceæ*, and *Typhaceæ*, has been already fully dwelt on [§ 1050], and the arborescent grasses have been likewise shewn, frequently, to assume the majestic growth of Palms [§ 1032, 1043]; the Palms also strengthen the similitude by occasionally becoming weak and flexible; such, for example, as the *Calami* or reed-palms, which furnish canes and walking-sticks, similar to the *Bamboos* and *Arundines*, or reed-grasses, whence they were called by Rumphius Palmi-junci or Palm-rushes.

(1080.) Two osculant points are thus observable, one between the *Sedges* and the *Rushes*, the other between the *Grasses* and the *Palms*. It therefore little matters which order is first described; but, as the *Juncales* seem to be in some measure transitional between the *Lilies* and the *Palms;* as the *Liliales* are between the *Bananas* and the *Rushes*, the former of which are the furthest removed from the Graminà, the precedence may perhaps with advantage be yielded to the Palms.

PALMALES.

(1081.) The Palms, exceeding most other plants in size, and surpassing all in grandeur and majesty of port, naturally commanded the earliest attention of mankind; and the innumerable purposes to which their fruit, their leaves, and their stems, have been applied as food, clothing, and shelter, as well as their constant ministration, even in an uncultivated state, to the necessities

of man, have worthily retained for them that regard which their beauty at first excited; and they are therefore still esteemed as

Iriartea ventricosa.

Elais melanococca.

some of the most valuable and important, as well as splendid vegetables known.

(1082.) The Palms were thus soon distinguished as a peculiar race, and designated by a peculiar name, which name and distinction they have ever since maintained: and, although it may be questionable, considering their organs of fructification, whether they should be ranked higher than as a section of the Liliales, yet, deference to established usage, and a consideration of their organs of vegetation, especially their arboreous stems, rigid divided leaves, median ovules, and aberrant embryo, as well as a regard to the botanical canon, which may be extended from genera to all natural associations, that the groups should furnish their own connecting characters, and not differential characters determine their bounds, combine to persuade the systematist to keep the *palms* in an order by themselves, although their strong similitude in various particulars to those which follow is at the same time neither unnoted nor forgotten.

(1083.) The Palms are arborescent Monocotyledons, with gene-

rally simple cylindrical lofty stems, occasionally, but very rarely branched, [§ 1081, 1093.] The rigid flabelliform or pinnati-sected leaves, are large, petiolated, and crowded at the extremities of the trunk or branches, the leaf-stalks partly embrace the stem, are invested with stipulaceous or ochrea-like membranes called reticula, and cover the stipes when they fall with successive series of induviæ or scars; the vernation is plicate, the leaves are non-reticulate, and the structure of the stem decidedly endogenous. The inflorescence is in catkins, or in large clusters or racemes, (called sometimes regimes,) which are furnished with bracteolæ, and often enveloped in large bracteæ or spathæ. The perianth is small and of six pieces, disposed in two series, so as to be equivalent to calyx and corolla, the sepals being often the smallest, and the petals connate. The stamens are rarely three in number, most frequently six, and either separate from, or united with, the pistils, the flowers being both monoclinious, monœcious, diœcious, and polygamous. The styles are three, often connate, stigmata simple, discrete or connate, germen superior, three-celled, two or one of which cells often become abortive, and the locules are one-seeded. The fruit is either a berry or a drupe, with fleshy or fibrous mesocarp; the ovule is attached not to the margin of the carpellary leaf, but springs from the median line, and is either sessile, as in *Chamærops*, or pedicled, as in *Rhapis*. The embryo is small, cylindrical, or turbinate, various in its situation, but usually distant from the hilum, enclosed in a hollow of the albumen, and covered with an operculum; the albumen is cartilaginous, and either ruminated, or with a central, rarely a ventral, cavity; the plumula is scarcely visible, and the cotyledonary end of the embryo greatly enlarged during germination.

(1084.) Thus it will appear that, from most other plants, the palms are distinguished by their in general simple stipites, covered with the remains, or marked by the scars, of successive crowns of leaves; from arboreous ferns in which these characters are present, they are known at once by their flowers, and by the foliage being formed of true leaves traversed by linear veins, and not being fronds bearing fructification on their backs. From *Cycadaceæ* their endogenous structure and covered seeds will separate them with facility, and with other sections there is scarcely any chance of their being confounded.

(1085.) From the above general description, it appears that their arborescent stems, rigid divided leaves, superior ovary, median

ovule, and aberrant included embryo, are the chief differential signs by which the Palms are distinguished from the other non-glumose monocotyledons, with which they are associated to form the present class.

(1086.) Martius, who has studied these plants more sedulously and with more favorable opportunities than most other botanists, estimates the number of existing species at upwards of a thousand, not a fifth part of which have however as yet been discovered or described. This calculation has been impugned by Schouw, but it seems to be confirmed by the observations of Humboldt and Bonpland.

The genera now known have been distributed, by Von Martius, into six subordinate groups, the differential characters of which are not, however, very decided, and they can scarcely be regarded as more than subtypes, associable into two types or subsections, the *Phœnicianæ* or *Phœnicaceæ*, in which the spathes are numerous and incomplete; and the *Arecianæ* or *Arecaceæ*, in which, when present, they are complete. Collectively, these two types or sub-sections form the section Phœnicinæ, the only one included in the order; for present knowledge does not justify a further primary subdivision.

PHŒNICINÆ

(1087.) *Phœnix dactylifera*, the date, which gives name to this, the single section in the order Palmales, is not improbably the very species to which the term *Palm* was originally applied; for it appears that of these noble plants three only were known to the ancients, viz. the Date, the Doum, and the Fan palms; and the Greek δακτυλος (dactylus), a *finger*, whence the present specific name dactylifera is derived, has a peculiar coincidence with the Latin *palma*, a hand, to the digits of which the bunches of dates were likened, and to which the fruit of neither of the others could have been compared.

(1088.) Phœnicaceæ. All those palms in which the spathes are numerous and incomplete, are included in the type *Phœnicaceæ*, which thus comprehends three or four subtypes, the *Calamidæ*, *Borassidæ*, and *Coryphidæ*, from which latter Von Martius separates the *Sabalidæ*.

(1089.) *Calamidæ*. *Calamus*, *Mauritia*, *Lepidocaryum*, *Sagus*, and *Raphia* or *Metroxylon*, in which the baccate fruit is covered by a tessellated rind, form the subtype *Calamidæ*. The inflores-

cence in these associated genera is in (catkins, or) amentiform regimes.

Sagus tædigera.

An amentiform regime, shewing the numerous small bracteæ or spathæ, and the baccate fruit with tesselated rind.

(1090.) *Calamus*, the reed-palm, forms the link to which reference has been already made, as connecting this order with the arborescent grasses, to which the several species are very similar in habit, seeming as it were to be gramina with the flowers of palms; the siliceous deposits on their leaves and stems, shew also a further affinity to the grasses.

(1091.) *Calamus scipionum* and *C. rotang* yield the celebrated rattan canes so much prized as walking-sticks, whence indeed is derived the specific name the former bears, in common with the affectionate and noble Roman, P. Cornelius, upon whom his father leant when blind as on a staff, and to whom, as a reward for his dutiful attentions, his fellow-citizens gave the surname *Scipio.*

Calamus rudentum, the cable cane, which is a native of the East Indies, Cochin China, and the Molucca Isles, exceeds in length all other palms, and perhaps is the longest vegetable known, sometimes growing to the almost incredible extent of 500 feet. These, as well as the other species of reed-palms, are applied to a variety of useful purposes. The more slender and flexible are commonly

substituted for ropes and cables, and employed in making wicker-work, hoops, and baskets; the more sturdy for props, poles, and walking-sticks. *C. zalacca* (the Salxck), is cultivated in Java for the sake of its fruit, which is about the size of a walnut, containing two or three sweet kernels, the tessellated rinds of which resemble the scales of a lizard. This palm is believed to yield the red juice which, when inspissated, is called *Dragon's blood;* but the finest is procured from the *C. draco.*

(1092.) The internal structure of the stems of many palms, as well as other plants, is soft and pith-like, and yields a very nutritious farinaceous substance called sago. This substance is particularly abundant in a species of palm called *Metroxylon sagus*, or *Sagus Rumphii.* There are several other species of this genus, as the *viniferum*, *Ruffia*, and *tædigerum* [§ 1089], all of which afford sago more or less abundantly, and furnish an important article of food to the inhabitants of Japan, and the many other countries in which they grow.

Metroxylon viniferum, of Rottbol, is the Raphia vinifera of other authors; it yields, when wounded, an abundant supply of sap: that in Guinea is fermented into an intoxicating liquor; if evaporated, a honey-like sugar is obtained; and when the acetous fermentation is favored, vinegar is produced from the sap of this, as well as of various other palms.

(1093.) *Borassidæ. Hyphæne*, *Borassus*, and their various allies, in which the inflorescence is, like the Calamidæ, in amentiform regimes, but in which the pericarps have not a tessellated rind, form the subtype *Borassidæ.*

The three-named *Hyphæne coriacea*, *Douma*, or *Cucifera Thebaica*, is the Doum-palm of Upper Egypt, and is remarkable for its dichotomous stem, by which it is strongly contrasted with the usual character of the order. It appears to have been known to Theophrastus, who called it *Cuci*, whence Delile's synonyme *Cucifera;* by the Arabians it is called Doum, whence Poiret's word Douma. In the country about Thebes vast forests of these palms are found. Their fruit is about the size of an orange, with a reddish rind; the inner parts are white and spongy, rather insipid, tasting a little like stale bread; they form a common article of food with the wandering tribes of Arabs.

Borassus flabelliformis is a very handsome palm, the fruit of which is as large as a child's head, and the stem, when wounded, yields a sap whence sugar may be procured, and which is frequently

fermented into wine. By *Gomutus saccharifer*, the Areng palm, sugar and wine are also produced.

A. Entire plant of Douma Thebaica, to shew its dichotomous stem. B. Amentiform regime of stamineous flowers. C. One flower isolated, shewing perianth and stamens. D. Bunch of fruit. E, F. Back and front view of the three ovaries. G. Fruit, one ovary perfected, two abortive. H. Vertical section of developed fruit. I. The nucleus. J. The embryo. K. Ditto cut lengthwise.

(1094.) *Coryphidæ*. *Corypha*, *Phœnix*, *Rhapis*, and their allies, *Sabal*, *Thrinax*, *Iriartea*, *Ceroxylon*, and *Chamædora*, although agreeing with the two preceding subtypes in having their spathæ numerous and incomplete, do not flower in amentiform regimes, and hence they are associated in the subtype *Coryphidæ;* and those genera in which the pistils are discrete have been distinguished from those in which they are coherent under the name *Sabalidæ:* the distinction, however, seems scarcely necessary.

(1095.) *Corypha umbraculifera*, the majestic Talipot palm of Ceylon, has been already figured in the general Outline, [§ 81.] Knox, in his History of Ceylon, describes this palm to be—

" As big and as tall as a ship's mast, and very straight. The leaves, which are very large, some capacious enough to cover from fifteen or twenty to thirty or forty men; these, he says, are of great use, for being, when dried, very strong and limber, though very broad when open, yet they will fold close like fans, and are then no bigger than a man's arm. The whole leaf-spread is round, but it is cut

into triangular pieces for use; these the natives lay upon their heads when they travel, with the narrow end foremost to make their way through thickets. The soldiers there all carry these umbrellas, not only to shade them from the sun and to keep them dry in case of rain on their march, but when set on-end, to make tents for them to lie under. A magnificent crown of leaves, as is usual with palms, terminates the stately column, 100 feet in height, which is formed by the trunk. The talipot bears no fruit until the last year of its life, and then yellow blossoms, most lovely to behold, but smelling very strong, come out on the top, and spread abroad in great branches; the fruit is in such abundance that one palm will yield seed enough to stock a whole country; the berries are round and hard, the size of our largest cherries, but not good to eat. The flowers smell so strongly that the Ceylonese cut the palms down, when growing near their houses, before the blossoms are open. The trunks when young are full of a mealy pith-like substance, which is beaten in mortars, and cakes made of it, that have very much the taste of ordinary white bread. The leaves are used instead of thatch for roofing houses, and also for writing on with an iron style. Most of the books shewn in Europe for the Egyptian papyrus are made from the leaves of this palm. In Malabar it is called Codda Panna, and very good figures are given in Rheede's Hortus Malabaricus."

Corypha Taliera is another magnificent species growing in the northern parts of India, and applied to many of the same economical purposes as the talipot is in Ceylon.; C. rotundifolia yields an amylaceous food, or kind of sago. The fruit of C. Pumos is eatable, and is sweet, and dogs are fed upon it in Mexico: and *Corypha cerifera*, which is a native of Brazil, receives its specific name from the wax-like matter it affords.

(1096.) *Phœnicia* formerly produced the best dates known, the date-palm was hence called *Phœnix*. It grows abundantly in Egypt, Arabia, Persia, and the neighbouring countries, and contributes largely to the support of the inhabitants, being in many places, as in Upper Egypt, the chief source of food.

The Date-palms being diœcious, (*i. e.* the stamens and pistils being not only in separate flowers, but growing on different trees,) the crops entirely fail, or the fruit is degenerate and unfit for food, if unseasonable weather, or any accident, should prevent the pollen of the stamineous plants having access to the flowers of the fruit-bearing ones. To ensure the fertilization of the seeds the Arabs have long been accustomed to gather the stamineous clusters and hang them over the pistilliferous flowers, and even to lay up stores of pollen from year to year. At the season when this is done a feast is held, called the Marriage of the Palms, of which Haselquist has given a very interesting account; and it is stated, that so well do the half-savage tribes know the importance of this process, that, during inroads into hostile countries, they cut down the stamen-bearing palms, as one of the most severe injuries they can inflict. Desfontaines was witness

to such an act of vengeance, and Kœmpfer relates that the threat of so doing once warded off an invasion; for, after describing the artificial fecundation of the date, he adds:

"I remember it happened in my time that the Grand Signior meditated an invasion of the city and territory of Bassora, which the prince of the country prevented, by giving out that he would destroy all the male palm-trees on the first approach of the enemy, and by that means cut off from them all supplies of food during the siege."

Phœnix dactylifera.

The extensive importance of the date-tree is, says Dr. Clarke, one of the most curious subjects to which a traveller can direct his attention. A considerable part of the inhabitants of Egypt, Arabia, and Persia, subsist almost entirely on its fruit; as a luxury they make a conserve of it, and they boast also of its medicinal virtues, esteeming it a tonic. Upon the abortive fruit and upon the ground-date stones, the camels are fed. From the leaves they make couches, baskets, bags, mats, brushes, and fly-flaps; from the trunk cages for their poultry, and fences for their gardens, and other parts of the tree furnish fuel. From the fibrous webs at the bases of the leaves, thread is procured which is twisted into ropes and rigging, and from the sap, which is collected by cutting off the head of the palm and scooping out a hollow in its stem, a spirituous liquor is prepared. Three or four quarts of sap may be obtained daily from a single palm for ten days or a fortnight, after which the quantity lessens, until, at the end of six weeks or two months, the stem is exhausted. So numerous being the uses of this palm, it is no wonder that it is highly prized, or that the native literati should have celebrated in verse and prose (as Gibbon informs us), the 360 uses to which the trunk, the stalks, the leaves, the juice, and the fruit, have been skilfully applied.

A single date-palm will bear upwards of a hundred-weight, and sometimes between two and three hundred-weight of dates in a season; they come into bearing at from six to ten years of age, and are fruitful for upwards of two hundred years. The amylaceous central part of the trunk is also good to eat, and the buds are esteemed a delicate vegetable. The young shoots are said to resemble asparagus.

The fruit of the *Phœnix farinifera* is eaten by the natives on the Coromandel coast, and from its trunk they procure a farinaceous substance resembling sago, but very inferior to that afforded by the Sagus.

The trunks of the palms being unbranched, and for the most part cylinders of

no great diameter, although some, as the Elais butyracea and Jubæa spectabilis, are three or even five feet thick, and their crowns of leaves being terminal, the wind has vast power over them, and the French, while in Egypt, are said to have applied this force to a very useful purpose, viz. to pump up the waters of the Nile, making them as it were levers to raise the pistons which fell again by their own weight.

Tamar is the Arabian name for the date, and critics suppose that *Tamar* (Ezek. xlvii. 19,) or *Tadmor* (1 Kings, ix. 18,) in the Wilderness, was so called from the abundance of palm-trees in the neighbourhood, whence the city was subsequently named by the Romans *Palmyra*, and both Wood and Bryant assert that it is still called Tadmor or Tedmor, by the Arabs, as it was by the Syrians in the time of Josephus.

Iriartea is an interesting genus, in which several of the species have their columnar stipites elevated on unearthed roots, as *I. exorhiza* and *I. ventricosa* [§ 1801], in which latter the stem becomes naturally tumid. The *Ceroxylon andicola* of Humboldt, which is now made a species of *Iriartea*, excretes a wax-like matter on its foliage, whence it has received its name.

(1097.) Arecaceæ. *Areca*, the betel-nut, and *Cocos*, the cocoa-nut, with various other genera in which the spathes when present are complete, form, collectively, the type *Arecaceæ*. This group has been distributed into two subtypes, the Arecidæ and Cocoidæ, the former of which, according to Von Martius, has a one-seeded berry; and the latter a one to three-seeded drupe: in the latter the complete spathes are always present, in the former they are often wanting. The distinction between the baccate and drupaceous pericarps is not, however, very decided in the palms, and therefore the subtypes are not here introduced.

There are several species of Areca, the best known of which is the A. catechu, as it affords the betel-nut, so much resorted to for its intoxicating and narcotic powers, [§ 75, fig. a.] This is almost the only palm which does not yield sago; but from its fruit an astringent extract is procured, that is brought into the market as an inferior sort of catechu. Slices of the betel-nut wrapped in a leaf of the betel pepper is a favorite masticatory in southern Asia. A little shell-lime is added to keep the taste and odour longer in the mouth. It gives the saliva a red hue like that of blood, and by constant use the teeth become blackened; it allays hunger, and is hence chewed, as tobacco is in Europe, to appease the appetite; and it is said to be considered the height of rudeness in the East to speak to a superior without having *a quid* of betel in the mouth, (Loudon.) It produces intoxication when first chewed, but this effect is soon got

over, and the natives say that it is a tonic, and moderates profuse perspiration.

Areca oleracea, the cabbage-palm, of the West Indies and the American continent, has so been called from the young bud being eaten by epicures, as coleworts are with us. This is one of the noblest of the American palms, rising sometimes to the height of 170 or 200 feet, and having a straight columnar stem of about seven feet in circumference. The fruit yields oil, the stem an inferior sort of sago, and the fibrous parts of the leaves are spun as hemp or flax, and made into fishing-nets and cordage of every kind.

(1098.) The *Cocoa-nut*, like the date-palm, is most eminently useful, and, like it, in the highest degree serviceable in the countries in which it grows; indeed, the history of the one is in great measure a counterpart of that of the other.

The stem when young affords a farinaceous food, when old the outer parts become so hard that swords and arrows are made of it, which it is said will pierce iron cuirasses. Sections of the stem are made into drums; and this curious timber is used in building houses and for various domestic purposes. The fibres of the leaves as well as the bastin of the pericarp are spun into thread, and cords, cables, cloth, &c. made from them. It is from this substance that coarse cloths and some of the more costly carpets are manufactured. The bases of the leaf-stalks and the *retinacula*, which are a modification of *ochreæ*, resembling coarse gauze, are used by the Indians as cradles and coverlets, the midribs are converted into oars, and the leaves furnish thatch, fences, and fuel, and when burnt they yield potash. The nuts afford an abundance of food; and the unopened buds are esteemed as a delicacy. The sap which exudes from the stem when the buds are cut off contains a large quantity of sugar, which may be separated by boiling, and is called Jaggery, or the sap may be fermented into an intoxicating liquor, whence the Pariah arrack is obtained by distillation. The unfermented sap is a grateful and wholesome beverage, and is regularly brought in large quantities to the markets, and sold under the name of *Toddy*. Ainslie recommends it to Europeans, especially delicate females, as the easiest and safest means of obviating or removing constipation. The milk of the young cocoa-nuts is a most refreshing drink; when old, it is thickened into a sort of cream, and subsequently,

a firm but hollow kernel is produced, which yields abundance of oil. This oil has lately become an important article of commerce; and even the nutshells are converted into cups, saucers, plates, dishes, mugs, bottles, boxes, rings, and a variety of articles both useful and ornamental.

Cocos capitata is a very handsome Brazilian palm; and another species of *Cocos*, the *aculeata*, is believed to yield the best palm-oil. It is, however, probable that palm-oil is obtained from several species as the Cocos butyracea or Elaeis guineensis, especially as the greatest quantities imported come from Africa, where it is used as freely by the negroes as olive-oil is by the Italians and Spaniards, their fish and rice being steeped in it, and their bodies anointed with it continually.

Cocos capitata.

(1099.) Numerous other palms, besides those already mentioned, yield wine, milk, cream, oil, butter, wax, resin, flour, sugar, salt, thread, cords, bows, arrows, and various other articles of food, medicine, furniture, and clothing to the natives of the countries in which they grow; but the above will afford sufficient illustrations of this order; and therefore much collateral matter, not immediately relevant, is suppressed, the introduction of which would be inconsistent with the brevity studied in these general Outlines.

JUNCALES.

(1100.) The rushes (*Junci*), and their allies, the rope-rushes (*Restiaceæ*), with the bur-reeds and reed-mace (*Typhinæ*), and other non-glumose monocotyledons, having naked flowers, or glumaceous perianths, and superior carpella, form the order Jun-

CALES, which seems to be in some measure intermediate between the *grasses* and the *sedges* on the one hand, and the *palms* and *lilies* on the other. The glumaceous perianths and albuminous seeds of the *Juncaceæ* and *Restiaceæ* connect them with the *Gramina* generally, while the included embryo of the rushes, and the excluded of the cord-rushes, are analogous to the included and excluded embryo in the grasses and the sedges. The foliage of these plants is also similar to that of the grasses, and hence they once were named *Vegetabilia graminifolia.*

(1101.) The rushes are on all hands acknowledged, by their pith-bearing stems, hexaphyllous perianths, and large firm, fleshy, or cartilaginous albumen, with included embryo, to evince a stronger affinity to the palms than is shewn by any other group, while the spathæ, spadices, and amentiform inflorescence of the palms, establish a secondary connexion between them and the spadiceous and spathaceous Typhaceæ, Callaceæ, and other types of the Juncales. The glumaceous perianths of some Juncaceæ approximate them to the semipetaloid types of the *Liliales*, while the exalbuminous seeds of the *Nayadinæ* and part of the *Acorinæ*, with the palmate or pedatinerved leaves of the *Callaceæ*, shew how many points of connexion exist between this and the following order, the LILIALES, *e. g.* in the *Dioscoraceæ*, *Smilaceæ*, and *Hydrocharinæ.*

(1102.) The several subordinate groups of rushes and rush-like plants associated to form the order *Juncales*, are distributable into four sections, which, from the respective normal genera *Typha*, *Acorus*, *Nayas*, and *Juncus*, are called the JUNCINÆ, NAYADINÆ, ACORINÆ, and TYPHINÆ.

TYPHINÆ.

1103. The floreeds (*Typhaceæ*), so called from the glumaceous scales when present being verticillate, and thus forming a calyx, constitute, with the screw-pines, (*Pandanaceæ*,) the section TYPHINÆ. This section contains very few genera, it has nevertheless been necessarily divided into two types, which differ, not only in their arboreous and herbaceous habits, but also in several important points of structure, viz. their respectively achlamydeous and mono-chlamydeous flowers, their multiple and simple fruits, erect and pendulous ovula, and entire and cleft embryos; the former being the differential characters of the *Pandanaceæ*, the latter of the *Typhaceæ.*

A. Creeping rhizoma of Typha latifolia. (*a*) Rootlets. (*b*) Leaves.

C. Culm with sheathing leaf-stalk (*a*). The phylloideous expansion (*b*).

B. Spadiciform inflorescence. (*a*) The lower pistilline flowers. (*b*) The upper stamineous ones.

D. Spike of Typha angustifolia, in which the predominant axial force has elongated the stem, and separated the pistilline flowers (*a*), from the stamineous ones (*b*), by the space (*c*).

E. Another spike, in which the same abnormal development has occurred in a still greater degree.

F. Stamineous flowers separated.

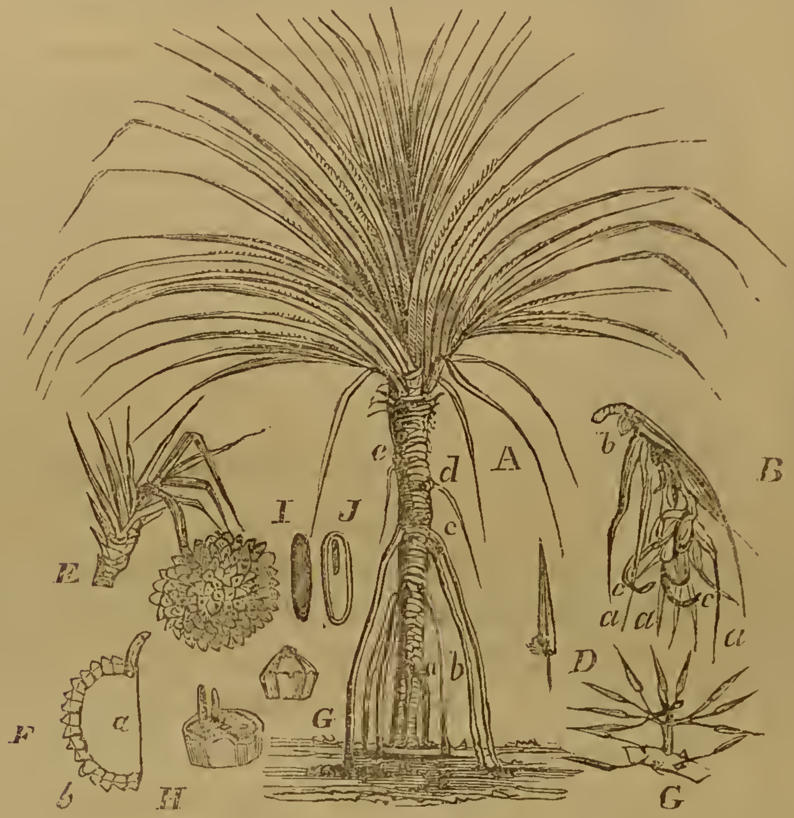
G. Pistilline ones.

(1104.) PANDANACEÆ. The screw-pine, *Pandanus*, with its allies, *Freycenetia*, *Cyclanthus*, and *Phytelephas* or *Elephantusia*, agree in having multiple fruit, erect ovules, and uncleft embryos; but they differ in having the former simple, and the latter divided leaves, the former absolutely achlamydeous flowers and discrete carpellæ, the latter an obscure glumaceous perianth, and the inflorescence spiral. Hence this type, small as it is, appears to require subdivision, for *Cyclanthus* and *Phytelephas*, by their possession of spathæ and their large frond-like divided leaves, approach more closely to the palms than do the screw-pines, and hence two subtypes may be distinguished, viz. the *Cyclanthidæ* and *Pandanidæ*.

(1105.) *Cyclanthidæ*. The fruit of the Cyclanthi is remarkable for its size; that of *Phytelephas*, or the Tagua plant, for the hardness of its albumen, whence buttons are turned. Both genera, and all the known species, are natives of America; but they are none of them very important in an economical point of view.

(1106.) *Pandanidæ*. The *Pandani*, like some of the *Cyclanthidæ*, are many of them arborescent plants, and are remarkable for their tendency to branch; an anticipation of which occurs in the Doum palm, although such a disposition is rare in the Endogenæ. *Pandanus candelabrum*, the Chandelier-tree of Guinea, has received its name from this natural peculiarity. The leaves are long, rigid, and undivided, and arranged spirally round the stem, or branches, whence they have been called screw-pines.

Pandanus odoratissimus, as well as other species of this genus, exhibit a strange semblance of instinct, in the development of aerial roots at different distances on their stem, by which their life is prolonged; and the fate common to most of the arborescent endogenæ for a time avoided. It is very curious to observe



A. Pandanus odoratissimus, entire plant, shewing the crown of foliage, and (*a*, *b*, *c*), subsidiary roots, protruded at different heights and periods. (*d*, *e*), young rootlets not yet having reached the ground. B. Stamineous flowers, (*c*, *c*, *c*), crowded in spadices *(b)*, and furnished with spathæ (*a*, *a*, *a*). G. Stamineous flower separate. D. A stamen dehiscing and expelling the pollen. E. Globular ament of pistilline flowers in fruit. F. Section of the fruit, shewing (*a*), the succulent receptacle, or spadix. (*b*), the carpels. G. A pericarp isolated. H. Horizontal section of the same, shewing the cells or locules, and the seeds. I. A seed isolated. J. A section to shew the situation of the embryo within the perisperm.

the device of nature to strengthen the stem, and to prolong the existence of these handsome plants. Being endogenous, the older and harder formations are outermost. But the diameter of the stem first formed being comparatively small, the outward wall has not had time to harden sufficiently to resist rupture by the descent of the root-fibres from the buds, as in the palms; and hence a swelling is perceived which subsequently rises into a tumour, and the roots, denied a passage downwards within the stem, descend externally from different distances to the earth; and thus not only strengthen the plant mechanically, but draw uncontrolled supplies of nourishment from the soil, their connexion with which would otherwise, from the peculiarity of their structure, have been cut off prematurely.

(1107.) *Pandanus odoratissimus*, the *Pandang*, of the Malays, grows abund-

antly in most of the warmer parts of Asia. It is a handsome arborescent plant, with shining dark-green leaves edged with prickles, and it is commonly planted in hedge-rows. The staminiferous flowers are delightfully fragrant, and are said to yield one of the richest perfumes known, for the sake of which this Pandang is cultivated in Japan. The soft bases of the leaves and the pulpy part of the fruit, although unpleasant, are eatable, and the Asiatics feed on them in seasons of scarcity; at other times they give them to their cattle as fodder. The soft spongy roots are used instead of corks; the fibrous leaves and stem are made into mats and baskets by the Tahitians, who stain them of different colours; they are also used for thatching and for cordage, and are made into a coarse kind of sacking. The bags in which coffee is brought to this country are for the most part made from the leaf-fibres of these plants. The fruit of *P. edulis* is esculent, and the terminal buds of *P. humilis* and *P. polycephalus* are esteemed, like those of palms, as food. The *Faquahiac*, which Mungo Park found in the interior of Africa, the fruit of which, he says, when ripe explodes and inflames spontaneously, by which many serious accidents have occurred, has been ascertained by M. Beaufort to be a species of Pandanus, who confirms Park's description.

(1108.) TYPHACEÆ. The reed-mace (*Typha*), and the bur-reed (*Sparganium*), form, together, a small type named the *Typhaceæ*,

Sparganium simplex.

A. Flowering stem, with *a*, *a*, *a*, pistilline flowers below; *b*, *b*, *b*, the stamineous ones.

B. A clavate or club-shaped stamen, with long lax filament.

which is closely allied to the *Cyperales*, especially to the section *Caricinæ*: for in the stamineous flowers the scales of the perianth are irregular or scarcely whorled, but in the pistilline ones the sepals are verticillate; and hence the type is removed from the *Gramina*, and combined with the glumaceous *Juncales*.

(1109.) The *Typhaceæ* differentially considered are subglumaceous monocotyledons, with triandrous separate flowers, and lax

filaments, single superior ovary, pendulous solitary ovule, and cleft embryo.

(1110.) The Typhaceæ are all aquatic or marshy plants, with perennial rhizomata; stems, round or angular; leaves (phyllodia) simple, with linear venation; inflorescence spicate or capitate; flowers monœcious; perianth subglumaceous or setaceous, stamina three; anthers club-shaped, filaments long and lax, ovarium single, ovule solitary, pendulous; pericarp dry and indehiscent, seed pendulous, albumen farinaceous; embryo straight, with a lateral cleft, and included within the albumen.

(1111.) The Typhaceæ are not very important plants; they are not known to possess any properties different from the ordinary sedges: like them they give an appearance of luxuriance, but afford a poor and scanty fodder to cattle in cold and damp, and otherwise barren situations, preparing the soil for the reception of more nutritious plants. The Typha has received its name from τιφος, a marsh, in allusion to its habitat; and its resemblance to that magisterial emblem of authority, a mace, has entailed on it the appellation reed-*mace*. It is the reed that painters usually figure in the Saviour's hand.

(1112.) The pollen of the Typhæ is inflammable, and is often substituted for the pollen-like dust of the Lycopodia, in pyrotechnic exhibitions. Its abundance and the ease of collecting it, is probably the cause of the substitution, for the pollen of any other plants would answer the same end. This pollen forms a stimulating application serviceable in the cure of indolent sores. The leaves are put by coopers between the staves of their casks to prevent leakage. They are also made into mats, or coarse chair-bottoms, and form good thatch. The downy seeds are used as stuffing for cushions; and in Germany the young roots are eaten in salads.

(1113.) The arborescent *screw-pines* (Pandanaceæ), seem to hold nearly the same relation to the more lowly bur-reeds (Typhaceæ), that the bamboos do to the meadow-grasses; or the arboreous ferns, fossil Equiseta, and Lycopodiaceæ, to the humble European Filices and modern existing genera; for, although the foliage of Pandanus is more similar to that of a pine-apple, whence, with the spiral exsertion of its leaves, the name *screw-pine* has been derived, than to that of the Typhaceæ, still its flowers bear so strong a resemblance to those of the bur-reed, "that it appears, (says Richard,) to be an arborescent species of it." And hence, although typically distinguished, it has been arranged with them in one common section, of which the collective characters are few and simple. They are arborescent or herbaceous Juncales, with subglumaceous or achlamydeous separate flowers, spadiciform inflorescence, solitary ovules, and fleshy or mealy albumen.

ACORINÆ, OR AROIDEÆ.

(1114.) *Arum* (the wake-robin or cuckoo-pint), with its allies, *Acorus*, *Lemna*, *Calla*, and *Orontium*, give evidence of a further progressive change in organization, and of this the types named, from the three latter genera, are the successive grades. The *Lemnaceæ*, *Callaceæ*, and *Orontiaceæ*, form, collectively, the section *Acorinæ*, the *Aroideæ* of many authors.

(1115.) The *Acorinæ*, are either annual or perennial plants, with usually grumous rootstakes, leaves often radical or alternate, inflorescence spadiciform, flowers either separate or united, and either naked or furnished with a perianth; the ovary is in general one-celled, containing several seeds; fruit dry or succulent; seeds mostly albuminous, and the embryo cylindrical and erect.

(1116.) Differentially considered the *Acorinæ* are Juncales with achlamydeous flowers, or squamaceous perianths, furnished with spathæ and albuminous seeds; the albumen being very rarely absent, and the spathæ sometimes leaf-like.

(1117.) ORONTIACEÆ. *Orontium*, *Acorus*, *Dracontium*, and

A. *Acorus Calamus*, and *A. gramineus*. (*a*) Rhizoma or prostrate root-stake, with roots and leaves (*b*) Base of flowering culm. (*c*) Flower separated, with its scaly perianth. (*d*) Ovary. A 2. *Acorus gramineus*. (*a*) Culm. (*b*) Leaf-like spatha. (*c*) Flowers congested on a spadix. B. Part of spadix magnified. (*a*) Stalk. (*b*) Base of spatha. (*c*) Spadix set round with flowers. C. Single flower isolated. (*a*, *a*, *a*) The sepals of the glumaceous perianth. (*b*, *b*) Stamina. (*c*) Stigma. (*d*) Ovary. D. Stamen, with the anther dehiscing. E. Ovary cut transversely. F. A seed. (*a*) The hilum. G. Vertical section of the fruit, shewing (*a*, *b*) fertile seeds. (*c*) Abortive ovule. H. Seed detached. (*a*) The fertile, (*b*) the abortive ovules. I. Section of the seed. (*a*) The seed coverings. (*b*) The albumen. (*c*) The embryo.

other *Acorinæ*, in which the united flowers are surrounded by a scaly perianth, form the type Orontiaceæ.

(1118.) *Orontium*, which denominates the type, is a name supposed to have formerly belonged to some plant, at present unknown, that grew abundantly on the banks of the Orontes. It is now applied generically to distinguish several exotic species, among which is the Tawkee (*O. japonicum*), the seeds of which Kalm states that the Indians eat when boiled as we do peas. Cattle are fond of the leaves of these plants, which grow abundantly in swamps and wet low grounds.

(1119.) *Dracontium fœtidum*, which possesses the odour and some of the properties of assafœtida, is said to be useful in cases of asthma. *D. pertusum* is a drastic purgative administered with advantage in some cases of dropsy; but, if taken in too large doses, it produces *risus sardonicus*, and other untoward effects.

(1120.) *Acorus Calamus* (the sweet smelling flag-rush), is our only indigenous plant which is at the same time both aromatic and bitter. It contains a considerable quantity of essential oil, that imparts the delightful fragrance for which it is peculiar, to the farinaceous substance abounding in its enlarged rhizoma. It is consumed in great quantities by perfumers and the makers of hair-powder. Indeed, in the neighbourhood of London, it has been almost wholly destroyed by their continual maraudings.

The root-stake of this plant affords a very agreeable tonic. In Constantinople it is made into a confection, which is considered a good stomachic, and it is eaten freely during the prevalence of epidemic diseases. In cases of chronic catarrh and humoral asthma, much benefit has been received from its exhibition.

(1121.) Callaceæ. *Arum*, *Calla*, *Caladium*, and the other acorinæ in which the flowers are achlamydeous and fruit fleshy, form the type Callaceæ; the *Aroideæ veræ* of Brown and Richard. Besides the above differential characters, these plants have pinnatifid or pedatinerved leaves, the veins not being parallel and linear, as is usual in the order to which they belong, but divided, and apparently interlaced, as in the foliar expansions of some frondose ferns; and simulating the manner in which the veins are reticulated in several groups hereafter to be described. The spathæ in this type are greatly developed, and the flower-stalk or common receptacle, is often continued beyond the insertion of the flowers, in the form of a succulent spadix.

(1122.) All these plants contain an acrid principle, which renders many of them highly poisonous. It is, however, most powerful in their fresh state, and may be removed by drying or boiling. Hence the roots of the common *wake-robin*, which are grumous and full of farina, although acrid when fresh, are manufactured into a bland and very nutritious food, sold in this town under the name of Portland sago; being so called from the Island of Port-

land, where the plant grows in abundance, and the manufacture is principally carried on. The roots of several of the *Caladia* are similarly used, although their sap is in general acrid, and that of *Caladium seguinum* so venomous, that, when a small piece of the plant is chewed, it paralyzes the muscles of the mouth and fauces, causes the tongue to swell, and deprives the sufferer of the faculty of speech; the sap of *Caladium arborescens*, although less powerful, is still so caustic, that occasionally (says Merat) the lips of the negroes are wetted with it, as a punishment for slight misdemeanours.

(1123.) *C. sagittæfolium*, the Brazil cabbage, is eaten when boiled instead of coleworts; the roots are less esteemed than the foliage, and the leaves are often used instead of plates and dishes.

Arum Dracunculus is a very remarkable and strange looking

Arum dracunculus (the dragon arum), shewing the open spatha and spadix, with stamineous and pistilline flowers, whorled nectaries, and crowded ovaria.

plant, the stem being spotted with purple and brown like the belly of a snake, and the lurid spatha and spadix stinking like carrion; the root is said to possess emetic powers. Arum colocasia is a common dietetic plant in Egypt and the Levant, both leaves and roots being eaten when boiled.

Caladium esculentum is also important as affording nourishment to many nations. Its roots, or rather rhizomata, are of great size and replete with starch; which, in the Canary Isles, in Brazil, and many other places, becomes one of the staple means of sustenance.

(1124.) Lemnaceæ. By *Lemna* (the water-lens or duck-meat), a connection is formed between the two previous types and several of the lower orders; for in *Lemna* the organization of flowering plants seems reduced to its simplest state, and indeed, in some species, propagation goes on indefinitely by buds, the flowers

having never been detected. Here neither leaf nor stem is formed distinctly, but the caudex becomes succulent and leaf-like, and

(*a, a*) *Lemna arhiza*, variety of (*b*) *Lemna minor*. (1) The cellular cryptophyllous stem. (2) The spongioles on the filamentary roots. (*c*) *Lemna gibba*, in a gemmiparous condition. (*d*) *Lemna polyrhiza*. (1) Stem, with latent foliage. (2) The numerous roots, with their spongioles. (*e*) *Lemna trisulca*. (1) Lobed subfoliaceous stems. (2) Radicles. (*f*) Parts of fructification. (1) Spatha with (2) flower, consisting of two stamens and one pistil destitute of perianth. (3, 4) Flower separated, shewing the same parts with the spatha (8) Spatha. (9) Flower without the spatha. (10) Seed. (11) Cleft embryo.

from its side proceed two naked stamens, generally accompanied with a single pistil, which constitute the flower. These plants are often unattached, and float about in the water at the mercy of the wind and waves; in them no spiral vessels have been as yet discovered; still the evolution of stamina and pistils associate them with the non-petaloid *palmares*, and their general structure with arum, of which some acute physiologists have well observed, they seem to be representatives reduced to the simplest form. From *Lemna*, the normal genus, this type has been called by De Candolle *Lemnaceæ*, which term is preferable to Pistiaceæ, proposed by Brown, for the latter word too much resembles in sound Pistacia, *Pistaciæ*, *Pistaciaceæ*, names already appropriated to very different plants.

(1125.) In the Lemnaceæ the fruit is dry, capsular, and indehiscent, the general axis abortive, and the stem and foliage united and undistinguishable from each other.

(1126.) Of the properties of these plants not very much is with certainty known. *Pistia stratiotes*, which is the Lemna of warm countries, like our Lemnæ, is often flowerless even in the Nile; and then still more strongly than usual reminds the botanist of Salvinia, of which it would seem to be a flowering

ally. It is said to be acrid, and when growing abundantly, as it often does in the tanks of the tropics, to render the water unwholesome, causing hæmorrhages from the bowels, if freely drunk. The Lemnæ are, however, harmless plants, which increase during warm weather with most astonishing rapidity. They are nutritious, and being a favorite food of water-fowl, are called duck-meat.

(1127.) *Arum*, and especially Calla, give excellent illustrations of the change or metamorphosis of the foliage into the more showy parts of flowers, for in Arum the inner surface of the enlarged bracte or spatha becomes variously coloured, and in Calla it gradually changes from green to a snowy white. Lemna likewise, by the union of stem and leaves, and the abortion of general axis, still further demonstrates the primitive identity of all these parts.

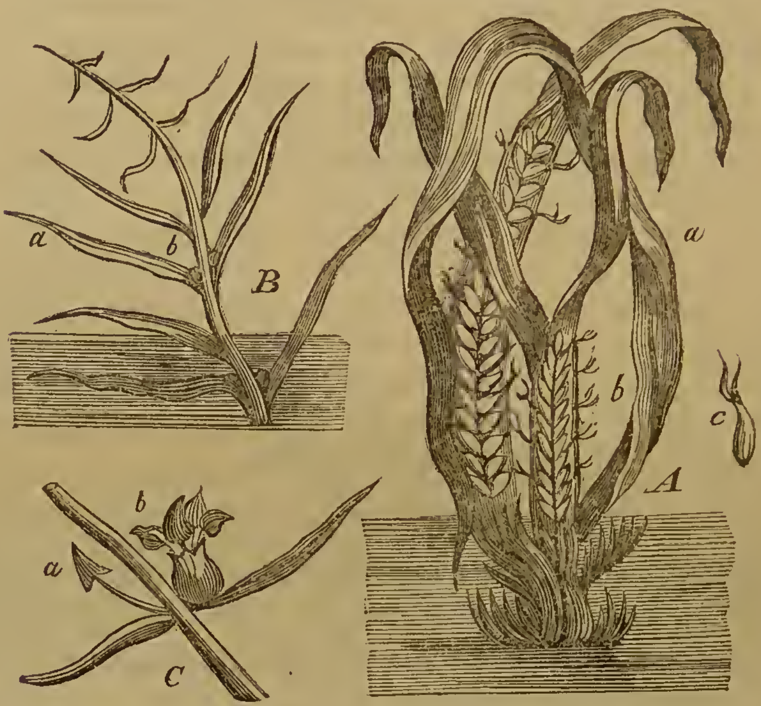
Several anomalous evolutions are observable in the plants included in this section, for not only are the tubular vessels occasionally obsolete, but the albumen is absent from some of the *Callaceæ*, as in *Dracontia fœtidum*, and *polyphyllum;* and in *Caladium* the embryo has no distinct cotyledon; it exhibits several germinating points, and is internally of a uniform structure resembling a spore; the leaves are also, in Callaceæ, subreticulated; and the stem and foliage in the Lemnaceæ undistinguishable.

NAYADINÆ.

(1128.) This section, which includes the exalbuminous Juncales, exhibits several strong points of resemblance to the preceding, the *Acorinæ*, and not a few to the succeeding, the *Juncinæ*, as well as to the *Alisminæ* of the order Liliales, and even to the Algæ. Their affinities are also not only many, but strong, for in each of the above-named groups some of the genera have been occasionally placed. To the *Acorinæ* they are allied by a similar gradation with them, from naked separate, or united flowers, with spadiciform infloresecence, to spathes and scaly perianths; and from them they are chiefly distinguished by their habit and exalbuminous seeds; for the latter of which the occasional absence of albumen in the *Dracontia* prepares the way, and corroborates the link. Their exalbuminous seeds also distinguish them from the *Lemnaceæ*, with which one type is closely associated in habit, and by its simply cellular structure; and the same character separates them from the *Juncinæ* to which the *Juncaginaceæ* form a transition; while their achlamydeous flowers or glumaceous perianth will distinguish them from the *Alisminæ*, to which by some writers they have been joined, on account of their exalbuminous seeds.

(1129.) Nayadaceæ. The grass-wreck (*Zostera*), and the river-guest (*Potamogeton*), with *Caulinia*, *Nayas*, *Zannichellia*, and other achlamydeous, exalbuminous *Juncales*, with separated flowers, one-seeded carpels, and intrafoliaceous vaginæ, form

collectively, a well-marked but not a very interesting type, called, from *Nayas*, a genus which, by its name, well indicates their habits, the NAYADACEÆ. They have also at various times been denominated



A. *Zostera marina.* (*a*) Foliage. (*b*) Spadices of flowers. (*c*) Pistil separated. B. *Zannichellia palustris.* (*a*) Foliage. (*b*) Fruit. C. Ditto, enlarged. (*a*) Naked stamineous flower. (*b*) Pistilline one.

Hydrogetons, *Potameæ*, *Fluviales*, and *Potamophileæ;* all terms having a similar reference to the places in which they are found.

Like the *Lemnaceæ*, these plants are believed to be destitute of spiral vessels, or, if not wholly absent, they are nearly obsolete: in *Caulinia*, Amici says no trace of them can be found. Their cellular structure likewise remains uncondensed in its outer layers; therefore no cuticular integument is formed, and they are devoid of stomata. Hence both these types descend in structure nearly to the rudimental state of the Algæ, from which, however, they are distinguished by their flowers, when other diagnostics fail.

(1130.) None of the Nayadaceæ are known to be possessed of any very active properties, and one only is much used by man, viz. the *Zostera marina*, which forms an excellent packing for brittle ware: this (the grass-wrack of mariners) is also platted into coverings for bottles and oil-flasks; and lately, under the name of *Alga marina*, it has been recommended as stuffing for mattresses, being tolerably light and soft, and intolerant of vermin; a great recommendation in many places.

The roots of *Aponogeton distachyum* are fed on by the Hottentots; and those of *Potamogeton natans* are sometimes eaten in the wilds of Siberia by men, but in more temperate regions they are fed on only by swans, who devour them with avidity. Ducks feed on the seeds and leaves of *P. crispus, P. densus,* and several other species; but these plants are more important from their functions of elaborating oxygen, and rendering water respirable for fish and other aquatic animals, than from the quantity of food that they afford; which is, however, by no means inconsiderable to the humbler tribes. Haller says, that *Potamogeton serratum* grows in the Swiss lakes to the enormous length of from ten to twenty fathoms, forming as it were extensive subaquatic forests in those vast natural reservoirs.

(1131.) Podostemaceæ. *Podostemon*, *Lacis*, *Marathrum*, and *Mniopsis*, plants very little known, constitute a type called the *Podostemaceæ* or *Podostemeæ*, which is distinguished from Nayadaceæ by having united flowers and many-seeded carpels.

(1132.) They are chiefly interesting as being the transitional series from the *Fluviales* or *Nayadaceæ* to the following group. To the *Nayadaceæ* and *Acorinæ* they are connected by the absence of calyx and corolla, and by the presence of a spatha, the structure of which allies them also with *Lemnaceæ ;* but in *Podostemaceæ* the seeds are numerous, while in *Lemnaceæ* they are few. Martius observes the resemblance which the first two genera have in their habit and mode of flowering to *Jungermanniæ*, as if they were noble monocotyledonous liverworts. These plants are aquatics, with their foliage developed rather in leaf-stalks (*phyllodia*) than forming true leaves. The perianth is absent; stamens hypogynous, definite, some sterile; fruit capsular; seeds exalbuminous and many: all of which characters associate them with Nayadaceæ, of which they might, almost with propriety, be considered a subtype, notwithstanding the opinion which has been adventured, that they are dicotyledons, and allied to the peppers; which, however, in turn, have been stated to be monocotyledonous plants, although the structure of their stem, and the venation of their leaves, are decidedly exogenous.

(1133.) Juncaginaceæ. *Trigochlin*, *Scheuchzeria*, and other achlamydeous or glumaceous plants, with hexandrous united flowers, dry fruit, erect seeds, and straight cleft embryo, form a type, which, from their rush-like habits, has been called *Juncaginaceæ ;* the old name for *Triglochin* being *Juncago*.

(1134.) The *Juncaginaceæ* are plants that delight in bogs, marshes, and other wet situations, but have not the floating habits of the *Podostemaceæ* and *Nayadaceæ*, but rather that of rushes,

to which they are closely associated by *Scheuchzeria.* Their exalbuminous seeds, however, easily distinguish them from the *Juncinæ;* and their glumaceous perianth, or naked flowers, from the *Alisminæ,* to which they are joined by Richard and Bartling. *Lilæa,* which is achlamydeous, connects them with the *Podostemaceæ,* as *Scheuchzeria* does with the *Juncaceæ;* and, should it cease to be a solitary exception, it may form the normal genus of a subtype: at present, however, further analysis is unnecessary.

(1135.) These plants are all innoxious, but none of them have been applied to any useful purpose: they contain very little nutritious matter, and form poor fodder, which but few animals will eat.

JUNCINÆ.

(1136.) The true rushes (*Junci*), and the cord-rushes (*Restiones*), are the normal genera of the two types, Restiaceæ and Juncaceæ, included in the section Juncinæ. The latter type approaches very closely to the Liliales, while the latter associates them with the sedges. They are glumaceous (rarely achlamydeous) Juncales, with large albumen, small embryo, and central placentæ.

(1137.) Restiaceæ. The genera which this type comprehends, although agreeing in the more important characters, differ in so far in minor particulars, that it is necessarily divided into three subtypes, called, from Centrolepis, Restio, and Eriocaulon, the *Centrolepidæ, Restionidæ,* and *Eriocaulidæ.* The first named is distinguished by having achlamydeous, monandrous flowers, with simple anthers, and numerous discrete carpella. The second, by its sepaloid perianth, simple unilocular anthers, and three or two celled capsular or drupaceous fruit. The third, by its sepaloid perianth, two-celled anthers, and three or two celled capsular pericarp.

(1138.) Collectively, the type is known from the Juncaceæ by the embryo being lenticular, outside the albumen, and remote from the hilum.

(1139.) Juncaceæ. *Juncus, Luzula,* and their allies, which form the type Juncaceæ, are distinguished from the preceding group by the embryo being always next to the hilum, and included within the albumen. The testa of the seed is also pale and soft, and the placentæ central.

(1140.) The Juncaceæ are generally herbaceous plants, rarely suffruticose; the rhizomata are scaly, with long subterranean di-

visions. Hence they are often planted to corroborate sea and river walls, and various embankments, as may be seen on our own coasts, but more especially on those of Holland, where the *J.*

A. *Juncus articulatus.* (*a*) Creeping or burrowing rhizoma, with culm and leaves. (*b*) Section of one of the cylindrical leaves, shewing their pithy diaphragmata. (*c*) Upper part of culm, with its panicle of flowers. (*d*) A flower magnified. † The glumaceous perianth. * The bracte turned down. (*e*) A flower opened, shewing the hexasepalous perianth, stamens, and pistil. (*f*) The capsule dehiscing, and shewing the central placenta. (*g*) Horizontal section. (*h*) The seed. (*i*) Longitudinal section, to shew the embryo included within the albumen, and near the hilum.

B. *Restio tetraphyllus.* (*a*) Entire plant, reduced. (*b*) Head of fertile flowers. (*c*) A fertile flower, isolated, with its bracte. (*d*) Perfect pistil, with two rudimentary stamens. (*e*) Fruit, natural size. (*f*) Ditto magnified. (*g*) Vertical section of pericarp, to shew the embryo remote from the hilum, and outside of the albumen.

C. *Restio tetraphyllus.* (*a*) Barren or stamineous plant. (*b*) Stamineous flowers in a capitulum. (*c*) One separated to shew the well-developed stamens.

acutus and *J. maritimus* vie with the mat-grasses and sand-sedges in protecting the low lands from the encroachments of the sea, by the strength their long interlacing roots give to the soil. The Juncinæ are none of them poisonous plants, but they are now applied to few domestic purposes, save the making mats, baskets, chair-bottoms, and brooms; their chief occupation being gone, since the advance of luxury has spread the apartments of our citizens with carpets, although, as late as the time of the last

Henry, the king's chamber was only strewed with rushes, and one of the charges against Cardinal Wolsey for extravagance was having his room restrewed so often as once a-week. Some of the Restiaceæ are used as thatching; and both them and the Junceæ, instead of twine: they are also twisted as substitutes for ropes; whence indeed sailors call cables *junks*, as *Juncus* itself is a derivative of *jungo*, to tie together or join.

In the Junci, the medullöid cellular structure, abundant in many of the palms, assumes still more the form of pith, and gives them in this respect somewhat the aspect of exogenous plants. "This pith is in great request to form the wicks for certain candles, which are hence called rushlights."

LILIALES.

(1141.) Lily (*Lilium*, λειριον, κρινον), probably derived from an Eastern word signifying a flower, or, as some affirm, from the Celtic *Li*, (whence the Gallic *Lis*,) *whiteness* or *shining*, is a name that has been given to many very different plants; such as the water-lily (Nymphæa), the superb lilies, now commonly so called, and others; even to the *Lilach* (Syringa), the original Persian name for which has been anglicised without alteration.

(1142.) The application of this term has been very variously extended and restrained; for the word *lily* has been used both as a general and an individual name. It was thus employed by the ancients, and also, among the moderns, both by Linnæus and Jussieu.

Solomon uses *lily* (Shushan) in a collective sense, and likewise distinguishes, among lilies, the Shushan of the valley; and "a Greater than Solomon," when he gave us the affectionate command to "consider the lilies of the field," seems, while adopting popular language, evidently to have had a similar comprehensive meaning, which may be shewn, both from the context and from modern phyto-geographical researches. Historical references, and a knowledge of local peculiarities, can alone fully develop the impressive beauty of this, as well as of many other passages in ancient records. Thus, for example, it is well known that fuel is so scarce in the Holy Land, and in many parts of the East, that the inhabitants regard large trees with especial reverence, and are obliged to use by turns every kind of combustible matter, such as the withered stalks of herbs and flowers, the tendrils of the vine, the small branches of rosemary, and other plants, to heat their baths and ovens. Allusion to this custom is easily recognized in this passage, and adds much natural force to Christ's concluding remark: "If God so clothe the grass of the field, which to-day is, and to-morrow is cast into the oven, shall he not much more clothe you, O ye of little faith?" The *grass* of the field

here evidently includes the lilies, of which the Saviour had just been speaking, and by consequence such herbaceous plants in general; and in such an extensive sense both words are not unfrequently to be taken. This will appear still further evident from the observations of Sir James E. Smith, who, when endeavouring to identify these lilies, which he considers not to have been *lilies* but *amaryllides*, says, "It is natural to presume, the divine Teacher, according to his usual custom, called the attention of his hearers to some object at hand, and, as the fields of the Levant are overrun with the *Amaryllis lutea*, whose golden liliaceous flowers afford in autumn one of the most brilliant and gorgeous sights in nature, the expression of 'Solomon in all his glory not being arrayed like one of these,' is peculiarly appropriate. I consider the feeling," he continues, "with which this was expressed as the highest honour ever done to the study of plants; and, if my botanical conjecture be correct, we learn a chronological fact respecting the season of the year when the sermon on the Mount was delivered." The white lily and the chalcedonian are, however, both Levantine plants; and many other lilies are natives of, and so abundant in the East, that a Persian province was called Susiana. and its chief city Sushan, from these beautiful flowers growing there naturally in excess. Hence, although the Amaryllis can by no means be excluded, the other Liliaceæ should be included likewise.

(1143.) Pliny ranked the lily next in excellency to the rose, and it is doubtful whether in external beauty it does not exceed it. Anacreon, in his odes, compares Venus to this flower; but perhaps with less than his usual felicity, as it has always been regarded as the emblem of purity and moral worth.

(1144.) Linnæus seems to have included in his general group Lilia all those liliaceous plants which form his natural orders *Sarmentaceæ*, *Scitamineæ*, *Orchideæ*, *Ensatæ*, and *Tripetalöideæ*, as well as his *Coronariæ* and *Spathaceæ*, or LILIES *without*, and LILIES *with Spathæ*. And Jussieu, although nominally reducing the Lilia to much narrower bounds, still indicates, by their relative position, their affinity to the subordinately distinguished groups.

(1145.) The peculiar advantages of these and other similar schemes of systematic arrangement are, on the one hand, accurate analysis; on the other, comprehensive synthesis; and, although not usually regarded as consentaneous, they are certainly not incompatible with each other. Therefore, while the modern natural subordinate groups of De Candolle, Brown, and others, are retained and distinguished by the ending of their names in *aceæ*, and the intermediate sections, which are nearly equivalent to the orders of Jussieu, are characterised by the suffix *inæ*, the larger collective orders of Linnæus have been preserved, but at the same time reformed; and are here known, as the major groups in the previous classes, by the termination of their names in *ales*. For *Lilia* in this, as well as Musæ, Pini, Zamiæ, Junci, and Rosæ in other orders, is inadmissible as a common collective term, from its being

like them only in the plural form of the generic name of the various normal species.

(1146.) The Liliales, differentially considered, are *Palmares*, or non-glumose monocotyledons, with superior (very rarely inferior) ovaries, ovules marginal, leaves undivided, seldom rigid, and perianth petaloid, often distinguishable into calyx and corolla.

(1147.) The several types included in the order Liliales are associable into three well-marked sections, which, from the normal genera, *Commelina*, *Alisma*, and *Lilium*, are called the *Liliacinæ*, *Alisminæ*, and *Commelineæ*, or *Ephemerinæ*: the first named comprehending the hexapetalous albuminous types; the second, those which are exalbuminous; and the third, all the tripetalous ones with albuminous seeds.

A. *Pontederia cordata*. (*a*, *b*) Cuttings, with leaves and flowers. (*c*) A flower opened, to shew the union of its six pieces, and the irregular disposition of the stamens. (*d*) A stamen detached. (*e*) The pistil separate, to shew the superior germen. (*f*) A transverse section of the ovary.

B. *Tradescantia virginica*. (*a*) A cutting, with leaves and flowers, shewing the tripetalous corolla. (*b*) A flower separate, to shew the trisepalouscalyx, (the inner whorl of the perianth being removed,) and the stamens and pistil. (*c*) A stamen detached, to shew the hairy filaments. (*d*) An enlarged view of one of the hairs, to shew its cellular structure. (*e*) The pistil denuded, to shew the superior germen, (*f*) the fruit, with the persistent calyx. (*g*) Transverse section of the trilocular capsule.

EPHEMERINÆ.

(1148.) Three small groups, which have been at different times more or less closely combined with the *Junci*, but which are rather transitional between the Juncaceæ and the hexapetalöid Liliales, than truly rushes, form the section EPHEMERINÆ, so named from the ephemeral duration of the blossoms of the principal genera: they have been also called *Commelineæ*, from Commelina, a genus commemorative of two Dutch botanists, John and Gaspar Commelin.

(1149.) The Ephemerinæ are tripetaloid Liliales, with superior ovaries, and albuminous seeds, with the embryo included within the albumen. The three associated types are named *Aphyllanthaceæ*, *Xyridaceæ*, and *Ephemeraceæ*.

(1150.) APHYLLANTHACEÆ. *Aphyllanthus*, *Dasypogon*, and *Callectasia*, are usually arranged with the rushes, forming only a subtype of the Juncaceæ, called *Aphyllantheæ*; but the true rushes seem to form a more natural group when they are excluded; and their connexion with the Juncaceæ is indicated even when they are distinguished as a separate type, transitional between the Juncinæ and Ephemerinæ.

(1151). The Aphyllanthaceæ are known by their tripetaloid perianth, central placentæ, seeds with soft pale testæ, and embryo included within the albumen.

(1152.) XYRIDACEÆ. This type was formerly a subsection of

Xyris operculata.

(*a*) A capitulum of flowers.

(*b*) A scale or bractea.

(*c*) The calycine pieces of the perianth.

(*d*) The corollaceous whorl, with the three stamina, three nectaries, and pistil.

(*e*) The fruit in an early state.

(*f*) Ditto, mature.

(*g*) The lower part of the pericarp.

(*h*) The operculum, or upper portion.

(*i*, *j*) Seeds enlarged.

the cord-rushes, but is well distinguished from them by the highly developed internal perigone or corolla. It connects this section with the *Ephemeraceæ*, or fading lilies, called likewise, from *Commelina*, the Commelinaceæ, but for which Batsch's synonyme, indicative of the delicate and perishable character of the blossoms, perhaps is preferable.

(1153.) The Xyridaceæ are tripetaloid *Ephemerinæ*, with concrete carpella, unilocular three-valved capsule, parietal placentæ, and included (?) embryo.

(1154.) EPHEMERACEÆ. The genera *Commelina*, and *Tradescantia*, [1147, B,] associate to form this type, in which the capsular fruit is two or three-celled, the placentæ central, and the trochlear embryo included within the albumen and remote from the hilum.

(1155.) The Commelinæ are ornamental plants, some of them commonly cultivated. None of them are deleterious, but not any are here employed either as food or medicine, although in America and in Cochin-china several species, as C. communis and C. medica, are esteemed sedative and expectorant; and the tubercles of C. tuberosa, which are sweet and savory, are eaten by the Chinese.

(1156.) So different in appearance are the delicate petaloid teguments of these plants from the husky perianths of the ordinary rushes, that their affinity might well be doubted by the common observer, did not aphyllanthes, usually placed among the rushes, with its pretty flowers, clearly indicate the connexion, which is still further substantiated by Philydrum, that seems to be a reduced Commeline, the petaloid perianth being only two-leaved, and the flowers monandrous, the two lateral filaments being barren. Dr. Brown has hence proposed to make this osculant genus typical of a subordinate group, which will again associate the *Ephemeraceæ* and the rushes, and to call it *Philydreæ*, or rather *Philydridæ*; it is readily distinguished by the diphyllous perianth.

ALISMINÆ.

(1157.) This section includes all the exalbuminous Liliales. The genera are associated in two types, named the Alismaceæ and Butomaceæ, which are often arranged with the *Juncaginaceæ*, on account of their seeds being destitute of albumen, but from which they are easily distinguished by their corollaceous perianth and uncleft embryo. This section appears to be

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transitional from the tripetaloid to the hexapetaloid liliales, and again, to connect both with the JUNCALES.

A. *Alisma plantago*. (*a*) Upper part of the flowering stem. (*b*) Radical leaf. (*c*) A flower separate, natural size. (*d*) Pistils. (*e*) Stamen magnified. (*f*) Fruit. (*g*) One capsule, separate. (*h*) Ditto, cut transversely, to shew the seed, consisting of a curved embryo with albumen. (*i*) The seed removed from the pericarp. (*k*) The embryo without the cotyledon. (*l*) A seed germinating. (*m*) A section of a young plant, to shew the plumula (*n*.)

B. *Butomus umbellatus*. (*a*) Phylloidaceous leaves. (*b*) Umbel of flowers. (*c*) One flower separate. (*d*) Pistils. (*e*) Carpels. (*) Horizontal section of the fruit. (*g*) A capsule separated. (*h*) Seed enlarged. (*i*) Longitudinal section of the same. (*k*) A seed beginning to germinate. (*l*) Ditto, more advanced. (*m*) Section of a leaf, to shew its angularity.

(1158.) ALISMACEÆ. The water-plantain (Alisma), the star-fruit (Actinocarpus), the arrow-head (Sagittaria), and other exalbuminous Liliales, with superior ovaries and few-seeded indehiscent fruit, are associated to form a type, called, from the normal genus, the Alismaceæ.

(1159.) They are water-plants often floating with lax stems on the surface, the rhizomata frequently large and fleshy, stem contracted, leaves radical, entire, with linear veins, and broad expansions. The flowers are either separate or united, the outer whorl of the perianth decidedly sepaloid, the inner corollaceous; the

numerous distinct carpels are dry and indehiscent, the seeds, one or two in each carpel, exalbuminous, and the embryo often curved.

(1160.) The Alisma Plantago has long enjoyed a not unquestioned reputation for its specific influence in the treatment of canine madness. Several cases have been published by Lewshin, Burdach, Moser, and others, in which it is asserted to have worked well-marked cures. Its root was administered in doses of two drachms and a half daily, and the leaves made into a poultice and applied to the wound. But, notwithstanding these assurances, it is probable that the escape of the patients alluded to should be rather attributed to the well known casualty of the hydrophobic poison having been never introduced, than to the antilyssic virtues of Alisma. The powdered roots have been substituted for uva ursa with advantage in cases of irritable bladder, in doses of a drachm.

(1161.) The tubers of this plant, as well as those of other the genera and species, such as Sagittaria, contain a good deal of amylaceous matter, and form a nutritious food. They are commonly eaten by the Kalmuc Tartars.

(1162.) BUTOMACEÆ. The flowering rush (*Butomus*), with its allies, *Hydrocleis* and *Limnocharis*, are distinguished as a type by the floral envelopes being still more petaloid than in the Alismaceæ; for in these the whole six pieces are more or less coloured. Besides the common characters of the section, they are well distinguished as a type by the rare occurrence of the vessels that nourish the erect seeds (and which are called the placenta or trophosperm,) being branched and spread in a reticulated manner over the sides of the one-celled three-valved many-seeded capsule. This structure is found in no other monocotyledons.

(1163.) This group, which is named from *Butomus*, the *Butomaceæ*, shows an affinity, by its highly developed and much coloured perianth, to future sections, in which the whole of the pieces are still more decidedly petaloid.

(1164.) The *Butomaceæ*, like the Alismaceæ, have a contracted general axis, and radical foliage and flower-stalks. The leaves, however, are unexpanded, and resemble phyllodia, linear, entire, and often sharp at their edges, and, from their cutting or injuring the mouths of cattle, the genus *Butomus* has received its name. Butomus umbellatus is one of the most beautiful British plants; its leaves are acrid, and are sometimes used as a purgative. Its

seeds and roots are recommended as antidotes to the bites of serpents.

(1165.) The sap in Limnocharis is milk-like, which is a rare occurrence in plants of this class; indeed, De Candolle says that no endogenæ are lactescent; the above is, however, an exception to the general rule.

LILIACINÆ.

(1166.) This section contains all the hexapetaloid *Liliales* with albuminous seeds. The perianth in these plants is for the most part regular, and altogether corollaceous, but more or less eminently developed in the several grades; the ovaries are superior, (very rarely inferior,) and the axile embryo lodged in a cavity of the albumen.

(1167.) The genera, which agree in the comprehensive characters of the section, are associated in five subsectional groups or types, in which the evolution of the perianth is gradually carried to its

A. Yucca Aloifolia. (*a*) Crown of foliage. (*b*) Inflorescence. B. Single flower of Yucca, to shew the highly developed perianth and superior germen. C. Aloe vulgaris. (*a*) Stem. (*b*) Rigid, fleshy leaves. (*c*) Flower-stalk. D. Spike of flowers. E. A flower separated. (*a*) The perianth. (*b*) The stamens. (*c*) The pistil. F. The stamens denuded of the perianth. G. Hemerocallis fulva.

acme of splendour, and again gradually wanes in beauty towards the tripetaloid groups of the succeeding order. From the normal genera *Pontederia*, *Asphodelus*, *Lilium*, *Colchicum*, and *Smilax*,

the types have been named the PONTEDERIACEÆ, ASPHODELACEÆ, LILIACEÆ, COLCHICACEÆ, and SMILACEÆ. This manifold distribution is required not only by the number of the genera comprehended in the section, but also by the essentially different habits and structural peculiarities of the groups themselves; but as the systematic distinctions are not very marked, perhaps the differential characters will appear in stronger relief by being collected and contrasted in immediate succession, than if distant references be made from one to the other in the course of the work alone.

(1168.) The PONTEDERIACEÆ have unequal stamens, and an irregular perianth, tubular at the base with a circinnate æstivation, and the segments are involute after flowering.

(1169.) The ASPHODELACEÆ have hexandrous (or by abortion triandrous) flowers, with introrse anthers; the perianth small, either regular or irregular; and the seeds with a black, brittle, crustaceous testa.

(1170.) The LILIACEÆ have hexandrous flowers, the perianth large and highly developed, the anthers introrse, the styles connate, and the seeds with a soft and spongy testa.

(1171.) The COLCHICACEÆ have hexandrous flowers with extrorse anthers, trifid, tripartite, or distinct styles, and occasionally inferior germen.

(1172.) The SMILACEÆ have united flowers, introrse anthers, fruit baccate or capsular, and seeds with a membranous testa.

(1173.) The DIOSCORACEÆ, which are often associated with the *Smilaceæ*, seem rather, by their constantly inferior ovaries, to be systematically allied to the *Musales*, between which and the present order they form the link of communication.

(1174.) PONTEDERIACEÆ. *Pontederia* [§ 1147, fig. A,] and *Heterantha* compose this small type, which is the osculant group between the *Ephemerinæ* and *Asphodelaceæ* of the *Liliacinæ*: it differs from the *Ephemeraceæ*, with which it formerly was blended, not only in the development of the perianth, but also in having the embryo axile, or in the same direction with the seed, it being the reverse in them, as well as in having a punctiform hilum, while in *Ephemeraceæ* the hilum is large, and occupies the entire side of the seed. Their differential characters have been already given, [§ 1170.]

(1175.) The Pontederiaceæ are aquatic plants, natives of the East Indies, Tropical Africa, and North and South America: they

are ornamental, and may easily be cultivated in an aquarium; their properties are unknown, and they have not hitherto been applied to any useful purpose.

(1176.) ASPHODELACEÆ. The genera Asphodelus, Aloe, Allium, Asparagus, Dracæna, Gilliesia, Hyacinthus, Scilla, and others, have been separated from the once unwieldy and heterogeneous assemblage, called by the older botanists *Liliaceæ*, and are associated to form the present type, by the characters already given in § 1169. They are evidently intermediate between the PONTEDERIACEÆ and LILIACEÆ, and their connexion is also strong with the JUNCACEÆ through *Aphyllanthes*. From all these orders they are however separated by the peculiar black, brittle, crustaceous testa of their seeds, as well as by the degree of development of their perianthium, which, although petaloid, and often beautifully so, is far less evolved and conspicuous than in the *Liliaceæ*, while in the *Juncaceæ* it is glumaceous.

(1177.) The *Asphodelaceæ* vary much in their size, some being small herbaceous plants, while others are arboreous in their port; their roots are fibrous, fascicled, or bulbiferous; leaves with parallel veins, and often grass-like; flowers united; perianth either regular or irregular; ovarium superior, three-celled; style single; stigma entire; capsule mostly three-celled, three-valved, with loculicidal dehiscence; seeds varying in number, with black, brittle, crustaceous testa; embryo included within the albumen.

(1178.) The genera contained in this type differ in having some an irregular depauperated perianth, while in others it is regular and well developed. Two subtypes are hence distinguished, the *Gillesidæ* and *Asphodelidæ*, the former being the *Gillesieæ* of Lindley, the latter the true *Asphodeleæ*.

(1179.) *Gillesidæ*. *Gillesia* and *Mersia*, Chilian plants, with small inconspicuous irregular Liliacinous flowers, grass-like leaves, and tunicated bulbs, form this subtype, which, although differing in the above particulars from the *Asphodelidæ*, cannot well be separated from them, and are therefore here considered as a member of the common type. They are neither ornamental nor useful, although, from their structure, curiously interesting plants.

(1180.) It is doubtful whether the remaining *Asphodelaceæ* should be all retained in one subtype, or be further distributed. Could constant and obvious differential characters be discovered, it would be convenient to have the numerous genera here collected arranged in smaller groups, especially as some indications, although

at present faint, are naturally apparent; but, notwithstanding various attempts have been made, it must be confessed that they have not been hitherto successful. Dr. Brown's *Hemerocallideæ*, sometimes placed in *Asphodelaceæ*, as by Bartling, and at others in part combined with the *Liliaceæ*, as by Lindley, might with some modification be retained as an intermediate group, or as a subtype of the latter, the genera with crustaceous testæ being of course excluded.

(1181.) Until a more intimate acquaintance with the minor affinities of these plants shall lead to the discovery of more natural associations, the Asphodelaceæ with regular perianths may be arranged in two subtypes, called, from their respective normal genera, the *Aloidæ* and *Scillidæ*, the first including the arborescent or herbaceous genera, with fibrous or tuberous roots, and the latter those which are bulbiferous. Both these subtypes are distinguished from the *Gillesidæ*, not only by their regular perianth, which is more evolved and petaloid, but also by their seeds not having the crustaceous testa continued over the podosperm.

(1182.) *Scillidæ*. *Scilla*, *Hyacinthus*, *Allium*, and *Ornithogalum*, are among the most useful and ornamental plants included in this subtype.

(1183.) The species distributed among the genera *Ornithogalum*, *Scilla*, and *Hyacinthus*, are not very well defined, so that several have been successively referred to either group, of which *Hyacinthus non-scriptus*, or *Scilla natans*, and *Scilla maritima*, or *Ornithogalum squilla*, are familiar illustrations.

(1184.) Hyacinthus is a genus long celebrated, not only for the beautiful fable whence its name has been fancifully derived, but also for the immense number of varieties which culture has produced. Of the *H. orientalis*, the common species, the Haarlem florists had at one time upwards of two thousand varieties; these bulbs, as well as those of the Tulip and Narcissus, once formed a most valuable, and still a not unimportant, branch of Dutch commerce.

(1185.) The *Squill* (*Scilla maritima* or *Ornithogalum squilla*,) is a native of the southern parts of Europe, growing freely on the sandy shores of Spain, Italy, and Greece. It has long been celebrated for its medicinal virtues; it is extremely bitter, and is esteemed as an expectorant, nauseant, and diuretic. The bulbs often attain a large size, being sometimes as big as a man's head.

(1186.) The bulbs of these plants appear, as De Candolle observes, to contain two very different proximate principles, the one a

Allium chamæmoly. Entire plant, to shew the bulb and fibrous root. (*a*) The six-parted perianth with perigynous stamens. (*b*) The superior germen. (*c*) The spathiform bracteæ.

bland nutritious farina, which resembles that found in the tubers of the *Orchidaceæ*, and the other a bitter gum-resin, giving more or less acridity and power to the bulbs, according to its relative predominance. The *Scilla lilio-hyacinthus* is purgative and diuretic, as well as the *Ornithogalum squilla;* and the *Moly* of Homer, there is little doubt, was a species of *Allium*, the whole of which are diuretic, expectorant, and more or less acrid; indeed, the common generic name is said to be derived from the Celtic word, *all*, signifying *hot* or *burning*. The onion (*A. cepa*), leek (*A. porrum*), rocambole (*A. scorodoprasum*), garlick (*A. ampeloprasum*), shallot (*A. ascalonicum*), and chives (*A. schænoprasum*), all belong to this genus, and are more or less esteemed as condiments or food. They contain free phosphoric acid, whence their peculiar flavor. This acid is in a great measure dissipated by heat, so that onions, when boiled or roasted, become comparatively mild; and those grown in warm countries seem to be naturally less acrid than those which are cultivated here.

(1187.) Garlic, and onions of various kinds, were highly esteemed in Egypt, and, according to Haselquist, not without reason. He conjectures that the A. cepa, which is still used in that country in amazing quantities, and forms a most delicious food, is one of the species of onion after which the Israelites longed when in the wilderness. He says, "whoever has tasted onions in Egypt will allow that none can be had better in any part of the universe. Here they are sweet, in other countries they are nauseous and strong; here they are soft,

whereas, in the northern and other parts, they are hard, and their coats so compact that they are difficult of digestion. Hence they cannot in any place be eaten with less prejudice and more satisfaction than in Egypt."

It was probably an assumption of austerity and show of ascetic self-denial which caused the Egyptian priests to abstain from the use of onions as food, and this subsequently led to the superstitious reverence with which by the bulk of the people they were regarded.

> "Vilia Niliacis venerantur oluscula in hortis,
> Porrum et Cepa Deos imponere nubibus ausi."
>
> *Prud.* l. ii. *contr. Sym.*

Lucian, when giving an account of the different deities worshipped in Egypt, states that the inhabitants of 'Pelusium adore the onion,' πηλουσιωταις δε κρομμυον. The Egyptians indeed were commonly reproached for swearing by the leeks and onions in their gardens; for Pliny says, "Allium cepasque inter Deos in jure jurando habet Egyptus," an absurdity which did not escape the scourge of Juvenal, whose nation was, however, not less absurdly superstitious than that against which his satire was directed.

> "Quis nescit, Volusi Bythinice, qualia demens
> Ægyptus portenta colit.
> Porrum et cepa nefas violare aut frangere morsu;
> O sanctas gentes quibus hæc nascuntur in hortis
> Numina." *Sat.* xv.

> "How Egypt mad with superstition grown,
> Makes gods of monsters, but too well is known.
> 'Tis mortal sin an onion to devour;
> Each clove of garlic has a sacred power.
> Religious nation, sure, and bless'd abodes,
> Where every garden is o'er-run with gods!"

But while some of the people did not dare to eat leeks, garlic, or onions, for fear of injuring their gods, others fed on them with enthusiasm, excited by the zest of appetite, if not by religious zeal, if we may judge from the distich which declares that

> "Such savoury deities must sure be good
> Which serve at once for worship and for food."

(1188.) *Aloidæ. Asphodelus, Aloe, Phormium, Xanthorrhea,* and *Dracena,* with other non-bulbiferous *Asphodelaceæ,* form the subtype *Aloidæ,* or *Asphodelidæ.*

(1189.) The *Asphodels,* as the name (α σφαλλω) imports, were great favorites in ancient times. They were vaunted as not to be surpassed, and were sacred to Proserpine. The gold and silver Asphodels have long been common ornaments of our English gardens; the latter species covers immense tracts of land in

Apulia, and affords abundance of nutritious fodder for sheep. The tubers of several species abound in fecula, mixed with a bitter principle, which, although unpleasant when they are eaten raw, is wholly removed by boiling; and it is said that swine are so fond of the tubers that they will unearth the roots to devour them.

(1190.) *Aloe* is a very extensive genus, containing many highly ornamental plants, and including several which afford that most serviceable drug which bears their name.

The Aloes are herbaceous or suffruticose plants [§ 1167, fig. c, d], almost assuming an arborescent port, with succulent foliage, and often elegant flowers. The species named *spicata* and *Socotrina* afford the spiked and socotrine aloes; the former is cultivated extensively at the Cape of Good Hope, and such large quantities of it exported, that it has in a great measure driven the socotrine from the market. This latter is made in various islands in the Straits of Babelmandel, but, being originally brought from Zocotra, one name is given to the whole. The Barbadoes aloes, which is imported from Barbadoes and other parts of the West Indies, is made from several different species, especially the vulgaris, socotrina, and arborescens: it is in general a less pure and sightly drug than either the socotrine or the Cape: it is chiefly used by farriers, and hence is called Caballine aloes. (Vide Med. Bot.) In countries where the woody prickly species naturally abound they are planted as hedges, and their leaf-fibres, after the juice of the leaves has been expressed, are macerated and made into cordage and coarse cloths.

Aloe dichotoma is the arrow tree of the Cape, and is so called from the Hottentots converting it into weapons.

(1191.) *Phormium tenax*, the New Zealand flax, is the plant concerning which such sanguine hopes were once entertained that it would prove a more fertile source of flax than Linum. But although the fibres yielded by its leaves are abundant and of good quality, still practical difficulties have hitherto hindered its profitable culture both in Ireland and New Holland.

(1192.) *Xanthorrhea hastilis*, the grass-tree of New South Wales, has received its generic name from the yellow gum that flows from it copiously, and which is known in the markets as *gum acaroides*. The plant is an exceedingly curious one, and, from the bases of the leaves remaining attached in congested whorls around the stem, it shews some similitude to the palms.

(1193.) The *Dracenæ* assume an arborescent port, emulating palms in their columnar stems, and even exceeding them, if not in height, in age; they are natives of warm countries, being indigenous to China, the East Indies, the Sandwich Isles, the Mauritius, &c. In the Canaries these plants grow to an enormous size.

"The Dragon-tree (Dracæna draco) of Orotava, in the island of Teneriffe, is between fifty and sixty feet in height; its circumference near the roots is forty-five feet, and at ten feet from the ground its diameter is twelve feet. It had attained this gigantic size when the Spaniards first landed in the island, in the fifteenth century. The trunk is divided into a great number of branches, which rise in the form o a candelabrum, and terminate in tufts of leaves, like the Yucca of Mexico. At the time of Humboldt's visit it still retained sufficient vigour to produce both flowers and fruit annually; but in July, 1819, one half of its enormous crown fell. It is now a noble ruin; but the wound has been plastered up, and the date of the misfortune marked on it: and the great care taken of '*the venerable vegetable*' will probably ensure its surviving another century.' —*Humboldt's Personal Narrative*, vol. i. p. 142; *Researches*, vol. ii. p. 209; and *Graham's Voyage to Brazil*, p. 85.

The red sap of D. Draco, when inspissated, is known as one of the kinds of Dragon's blood. It is a styptic, but not much used. D. terminalis is planted as a land-mark in India and China, to divide

Dracæna Draco.

A. An aged tree. B. A younger one, to shew the columnar stem and terminal tuft of leaves. B. A branch, with its crown of foliage and flowers. D. Flowers separated. E. A stamen attached to one of the pieces of the hexapetaloid perianth. F. Stamen separate. G. The pistil. H. The fruit.

estates, and to note the bounds of territorial property; hence its specific name. It yields a syrup-like juice, from which sugar may

be obtained: the Sandwich Islanders prepare an inebriating liquor from this sap, which the Tahitians call *ava;* and the English have converted it into a sort of rum. The root of the plant is esteemed by the Javanese as a valuable medicine in dysentery.

(1194.) LILIACEÆ. *Lilium*, and its more immediate allies, *Tulipa, Polianthes, Fritillaria, Hemerocallis,* and other liliacinous plants, with large and highly developed petalöid perianths, introrse anthers, three-celled polyspermous capsules, and seeds with

A. Scaly bulb of *Lilium candidum*. (*a*) Roots proceeding from the lecus. (*b*) Young bulb or offset. (*c*) Scales of the bulb. (*d*) Bases of the leaves.

B. Section of the bulb, to shew the lecus, the scales, and the bud on the abortive axis. I. A scale, with a small bulb in its axilla.

C. The summit of the stalk, with flowers. (*a*, *a*) Bracteæ. (*b*, *b*) Opened, (*c*) unopened flowers. (*a*) Pistil denuded of the perianth. (*d*, *c*) The capsule, shewing its cells. (*f*) Seeds. (*g*) Stamens and pistils in an early stage.

I. Portion of the cuticle, to shew the stomata.

D. Bulb of *Ornithogalum Squilla* [Scilla maritima]. (*a*) The roots, (*b*) the scales, (*c*) the stem. E. Raceme of flowers. F. Perianth with stamina. G. A bracte. H. Pistil, shewing germen and style.

soft, membranaceous or spongy testæ, are associated to form this type, which, although it retains the title of the former unwieldy group, is, by the exclusion of the *Pontederiaceæ, Aphodelaceæ, Colchicaceæ, Smilaceæ,* and *Dioscoraceæ,* not only very much reduced in extent, but relieved of its complexity.

(1195.) From the *Asphodelaceæ* it is distinguished by the more highly developed state of the perianth, and the soft membranace-

ous seedcoats; from *Colchicaceæ*, by the introrse anthers; from *Smilaceæ*, by the more petaloid perianth, capsular fruit, and single style; from *Dioscoraceæ*, by the superior germen; and from *Pontederiaceæ*, by the irregular perianth of these latter, the pieces of which become involute after flowering.

(1196.) The Liliaceæ thus defined include *Hemerocallis*, and part of the *Hemerocallideæ*, of Dr. Brown, the other genera of which order, as Aloe, from the crustaceous texture of their seedcoats, have been associated with the Asphodelaceæ.

(1197.) *Lilium*, the normal genus of the type, contains some of our most splendid and favourite garden plants, such as the White Lily, the Tiger, the Japan, the Superb, the Orange, the Turk's cap, and other species. They are chiefly cultivated as ornamental plants; but their bulbs contain mucilaginous and farinaceous matter, and, although slightly bitter, are eatable. Some of them are cultivated abroad as the potato is here, and commonly fed on in Siberia: such as the *L. Kamtschatchense*, *L. martagon*, *L. pomponium*, and *L. candidum*. In this country they are frequently used for emollient poultices. The scent of the lily is so powerful, that it distresses many people to have the flowers near them, especially in a room; and Murray mentions some cases in which death has been caused by the odour of these plants.

(1198.) *Tulipa*, a corruption of the Persian word *Thoulyban*, is the name given to a genus of very shewy scentless flowers, which have been rendered famous from the commercial gambling of the Dutch in the seventeenth and eighteenth centuries. To such an excess were fictitious speculations then carried, that the madness of the period was not inaptly termed Tulipomania. Single bulbs were bargained for, to be bought or sold, for upwards of 500*l.* a-piece; but the plants themselves were seldom either delivered or received, the difference in their value, like the difference in the price of stocks, being lost or won according as such and such tulips were quoted higher or lower in the market at the time contracted for than the price agreed on. When the delirium began to subside, the bulbs were proffered instead of cash, and then their nominal value quickly sank, the bubble burst, and tulips were banished to the garden from the Stock-exchange.

Many hundred varieties of tulips are known, some of which are very splendid flowers.

(1199.) The different species of Yucca, or Adam's needle, Hemerocallis, or day-beauty, and Polianthes, or tuberose, are general favourites as ornamental plants. The Tuberose is famous for the fragrance of its flowers, which is the most powerful in the evening. Like the Tropæolum, the petals of this plant have been observed occasionally to emit sparks, supposed to be of electric origin.

(1200.) Colchicaceæ. The genera *Colchicum*, *Melanthium*, *Hermodactylum*, *Helonias*, *Veratrum*, *Gloriosa*, and other Liliacinæ, with extrorse anthers, distinct styles, and subdiscrete carpella, form a type, which has been named after several of the included genera, such as *Veratrum*, *Merendera*, and *Melanthium*; but perhaps De Candolle's term Colchicaceæ is preferable to any of the others.

(1201.) So similar are these plants in their general characters to the Liliaceæ, that some botanists have proposed to conjoin the types; but their properties are so dissimilar from those of the true lilies, and so peculiar to this group, that it would be a matter of regret if they could not be systematically kept apart.

A. *Colchicum autumnale*, or Meadow Saffron. (*a*, *a*) The lecus, or bulb plate. (*b*) The radicles springing from the lecus, or abortive descending axis. (*c*) The solid bulb. (*d*) The radical tube of the perianth. (*e*) The tube, with the pistil passing down it. (*f*) The limbus, or border of the perianth, composed of six connate pieces, and shewing the stamens within.

B. The foliage (*a*), with the young fruit (*b*).

C. The capsule, three-celled, with central placentæ.

D. Transverse section of a bulb, (*a*) rootlets, (*b*) cormus, (*c*) radical tube.

E. Longitudinal section, (*a*) cormus, (*b*) tube.

Veratrum album. F. Amplexicaul leaf. G. Summit of stalk, with flowers. H. Flower divested of perianth, and shewing (*a*) stamens, (*b*) pistils. I. Stamineous flower, (*a*) bracte, (*b*) perianth, (*c*) stamens. (J) Stamens divested of perianth. K. A single stamen, (*a*) filament, (*b*) anther dehiscing.

The active principle almost peculiar to these plants, and which gives to them their power, has been called *veratrin*. It is blended in the cormus of the common colchicum with a great deal of amylaceous matter, which, when it has been removed by boiling, is nutritive, and is said to be then eatable, although, when taken raw, it is highly poisonous. The virulence of these plants differs, however, in different seasons, and is varied by situation. Travellers assert that colchicum is eaten in Carniola, in the autumn, without inconvenience.

The Hermodactyl of the Greeks is believed to have been either a species of colchicum, or an allied genus. It was a celebrated remedy for the gout in ancient times, and has again recovered its celebrity, being one of the reputed bases of the "Eau medicinale." The poisonous principle pervades every part of these plants, being found not only in their roots, stem, and leaves, but also in their flowers and seeds.

(1202.) The Colchicaceæ are evidently transitional from the Liliaceæ to the Smilaceæ; for the solid bulb, or *cormus*, of colchicum is formed by the axis not being so far abortive as in the *lecus* of the true bulb; and in Veratrum the descending axis is prolonged so as to constitute almost a fusiform root, with the rootlets lateral instead of being crowded on the base, as when the rootstock is aborted. In Veratrum, too, the perianth becomes rather less petaloid; and in Campynema the germen is inferior, as in Dioscoraceæ.

(1203.) SMILACEÆ. The *Smilaceæ*, including Smilax, Ruscus, Trillium, Paris, and other less important genera, are, on the one hand,

A. *Paris quadrifolia*, entire plant, shewing the creeping rootstock, the four verticillate leaves, and the flower. (*a*) The fruit and perianth. (*b*) Section of the fruit. (*c*) Perianth, stamens, and pistils. (*d, e*) The germen, surmounted by four stigmata.
B. *Smilax sarsaparilla*. C. *Smilax China*.

associated with the *Dioscoraceæ* by their broad leaves with reticulated veins, common to several genera, and, on the other, with the *Asphodelaceæ* by their generally perigynous, introrse anthers, and superior three-celled ovarium; so that they have frequently been combined, either wholly or in part, with both. The characters, however, which associate them most strongly with either, distinguish them from the other: thus, the superior ovarium takes them from Dioscoraceæ, and the broad reticulated leaves from Asphodelaceæ; and such genera as have the foliage not reticulated, are known by the triple style and membranous testa, which latter is characteristic of, and common to, all the Smilaceæ. The Smilaceæ, thus characterised, are divided into two subtypes: 1st, the *Smilacidæ*, in which the stigma is simple or three-lobed, as in Smilax, Ruscus, and Convallaria; and, 2d, the *Parisidæ*, in which the several stigmata are distinct, as in Paris, Trillium, and Medeola.

(1204.) *Parisidæ.* *Paris quadrifolia*, which is an indigenous plant, and *P. polyphylla*, a native of Nepal, are both poisonous, the latter more especially so. *Trillium* likewise, which is curious for the threefold arrangement of all its parts, the stem being three-leaved, the calyx three-sepalled, the corolla three-petalled, the stamens twice three, and the pistil with three styles, is a suspicious plant; its roots are violently emetic, and its fruit deleterious. The properties of this subtype seem to bring them nearer than the Smilacidæ to the Colchicaceæ.

(1205.) *Smilacidæ.* Various species of the genus Smilax are esteemed for their alterative properties; they are tonic, diuretic, and demulcent. *Smilax aspera* is by some preferred to the drug we use under the name of sarsaparilla. The so-called sarsaparilla of the druggist is not, however, the produce of *S. sarsaparilla*, but of *S. sarza*, as the species is now named. The large fleshy subrotund rootstock of *S. china* is eaten in the Celestial Empire instead of rice; and the Abbé Rochon attributes the corpulency of the Chinese in part to its consumption.

MUSALES.

(1206.) *Musa*, *Urania*, *Heliconia*, *Thalia*, *Iris*, *Agave*, *Aglaia*, and the numerous other names of classical celebrity conferred upon the plants included in this order, would seem to be indicative of the admiration which their magnificent and graceful port, their

curious structure, and their splendidly beautiful flowers are well calculated to excite, and the homage which they appear universally to command. For, notwithstanding some stern etymologists suppose *Musa* [§ 75, B,] to be a corruption of *Mauz*, the Arabic name of the plant, while antiquarians consider it to be commemorative of *Antonius Musa*, the freed-man of Augustus, and *Thalia* of a German physician, still the correlatives *Heliconia*, *Urania*, and

Urania Ravenala.

A. Entire plant. (*a*) Columnar stem, marked with the scars of the fallen leaves. (*b*) Leaves, with their vaginal petioles and lacerated expansions. (*c*) Leaves entire during early growth.

B, C. Flowers separated. D. Transverse section of the three-celled fruit. E. Longitudinal section of seed, shewing the included embryo. F. Transverse section of the same. G. The seed, with the arillus removed. H. A seed, with the arillus.

Aglaia, sufficiently shew in what sense they have been ordinarily taken; and, if terms of exuberant praise are fit denominations for any plants, they are not undeserved by these.

(1207.) The inferior fruit, with a tripetaloid or hexapetaloid perianth adnate to the germen, are the chief characters which associate the genera included in this large order. But, although agreeing for the most part in these common characters, they differ

in the structure of their leaves, the development of the perianth, the presence or absence of albumen, the union of the stamens with the pistil, and other particulars by which they are distinguished into fifteen types, associable into five sections, called TACCINÆ, NARCISSINÆ, SCITAMINÆ, ORCHIDINÆ, and HYDROCHARINÆ.

TACCINÆ.

(1208.) *Tacca* and *Ataccia*, with *Dioscorea*, *Tamus*, and *Testudinaria*, are illustrations of the section TACCINÆ..

(1209.) The genera included in this first section of the Musales are associated into the two types *Dioscoraceæ* and *Taccaceæ*, which seem to be intermediate between the present and the two preceding orders. Indeed, the Dioscoraceæ have most commonly been placed among the Liliales, next to the Smilaceæ; and the Taccaceæ blended with the Acorinæ, or Aröideæ, of the Juncales. Their inferior fruit will, however, sufficiently distinguish them from both these orders; and the petaloid perianth of the latter forbids its intimate association with the achlamydeous or glumaceous sections.

(1210.) Differentially considered, the Taccinæ are hexapetaloid monocotyledons, with inferior ovaries, large grumous roots, or rhizomata, and petiolate, pedatinerved, pinnatifid, or subreticulated leaves. And, although differing considerably in habit and in appearance, the dissimilarity of both from the other sections in this order tends to strengthen the association which their agreement in these various particulars suggests.

(1211.) TACCACEÆ. *Tacca* is the Malay name of a genus, of which there are but two known species. One of these, the *T. pinnatifida*, is a most important plant, as affording food to the natives of the South Sea Islands, where corn and our esculent grains are unknown. The part chiefly eaten is the enlarged root-stake, that, like the yam and some of the Aröideæ, contains much farinaceous matter, which, washed and well prepared, is both palatable and nutritious. In their raw state the roots are bitter and acrid, and require to be rasped fine, and steeped in several waters, before the acrimony is removed. Thus prepared, the meal is made into cakes and loaves, being even preferred to sago bread. The leaf-stalks, when boiled, become mild, and are, when thus cooked, esteemed as food in China and Cochin-China. When beaten into a soft pultaceous mass, these roots form excellent poultices.

(1212.) The *Taccaceæ* are large, perennial, herbaceous plants, with tuberous rootstakes, and shortened or abortive superior axis; having exstipulate, radical, petiolate, pedatisected, pinnatifid, or rarely entire leaves, with a curvilinear venation. The flowers are united, hexandrous, and the filaments free but dilated; the tube of the perianth adnate to the germen; the limbus six-parted, petaloid, and persistent; ovaria three, and connate; the fruit baccate, indehiscent, unilocular or subtrilocular, and many-seeded, with parietal placentæ. Seeds lunate or subovate, testæ striate; and the embryo situated on the outside of the fleshy albumen.

(1213.) The radical leaves, and baccate fruit, with parietal placentæ and lunate or subovate seeds, are the differential signs of this type, when added to the common characters of the section.

(1214.) DIOSCORACEÆ. This, once arranged as the concluding type of the Liliacinæ, indicates by its characters the transition to another order. The perianth is the least petaloid and the most herbaceous of the whole series; the genera agree in habit, and in the venation of their leaves, with the Smilaceæ, but are distinguished by their inferior fruit, which associates them with the MUSALES. The leaves are peculiarly reticulate, resembling closely those of Exogenous or Dicotyledonous plants, hereafter to be described; and they differ, on the whole, in so many particulars from other tribes, that they would seem to occupy the neutral ground, rather than of right to be classed with any.

(1215.) A small herbaceous or subpetaloid perianth, regular and spreading; separated flowers; inferior germen; baccate or capsular fruit; albuminous seeds, and small embryo, included in a large cavity of the cartilaginous albumen, are the associating characters of this type, and those which distinguish it from all others. The plants have a climbing habit, and alternate leaves, that are either reticulate or palmatinerved.

(1216.) *Dioscorea*, the yam, and *Testudinaria*, the Hottentot's bread, are the most important genera in the type. *Tamus*, the black briony, is the only European representative. The roots of *Tamus communis* are large, and replete with fecula, which is however mixed with a bitter acrid matter, that renders them unpleasant to the taste, and probably unwholesome. Heat and repeated washing will, however, destroy all the bitterness and acridity, and the fecula which remains forms a nutritious food. Attached to the roots of Tamus are blackish tumours, which should be removed from those intended to be eaten; for they are so exceedingly acrid, that, when beaten into a pultaceous mass with the rest of the root, they have been used as stimulating plasters. The young shoots of this plant

have a mild agreeable flavour, and form a very good substitute for asparagus. By the Moors they are boiled, and eaten with oil and salt.

(1217.) Several species of *Dioscorea*, or yam, such as the *alata*, *sativa*, and *aculeata*, are cultivated in warm countries as the potato is with us. Their roots are very large, sometimes weighing even as much as thirty pounds. Like the briony, when fresh, they contain an acrid juice, which causes itching if applied to the skin, but, being mixed with so much more fecula, it is less irritating than the Tamus. By heat this acrid principle is wholly dissipated, and either boiled or roasted they form a light, nutritious, palatable food. They are very mealy, and can be made into either bread or puddings, and are not inferior in flavour to any such vegetables now known. In Tahiti a favourite dish is made of yams, with scraped cocoa-nut and the pulpy fruit of the Banana.

Testudinaria elephantipes.

(*a*) Flower.

(*b*) Rootstock, voluble stem, and reticulate leaf.

(1218.) The *Testudinaria elephantipes*, or Hottentot's bread, [§ 1220,] is a very curious plant, resembling in its rootstock a tortoise encased in its protective shell. My friend, Mr. Burchell, to whom we are so much indebted for information collected during his travels in Africa, tells me he met with it frequently; and in times of scarcity the Hottentots break off the woody case, and eat the pithy substance it contains, whence the name Hottentot's bread.

NARCISSINÆ.

(1219.) The angular and sedge-like leaves of some of the *Ephemerinæ* prepare the way for the sword-shaped foliage which prevails in the several groups of plants which have, from this circumstance, been denominated Ensatæ, and which, although divided into separate orders by many persons, are more naturally and conveniently collected into one section; subdivisions of which they will be here considered.

(1220.) The *Narcissi* and *Amaryllides*, with the corn-flags, or *Irides*, [§ 75, D, E,] saffrons, or *Croci*, and the pine-apples, or

Bromeliæ, are familiar illustrations of this section, and of three out of the four types that it contains, viz. *Bromeliaceæ*, *Amaryllaceæ*, and *Iridaceæ:* the fourth type, *Burmanniaceæ*, includes only exotic plants, such as *Hæmodorum*, the blood-wort, *Dilatris*, *Burmannia*, and others; no British representative being known.

(1221.) Differentially considered, the *Narcissinæ* are tripetaloid or hexapetaloid *Mucales*, with triandrous or hexandrous flowers, central placentæ, albuminous seeds, and nervo-striated leaves.

(1222.) Bromeliaceæ. *Ananassa*, the pine-apple, with Bromelia, the genus in which it was formerly included; the *Agave*, or American aloe; the parasitical *Tillandsia*, *Pitcairnia*, &c., constitute two sub-sections of a group denominated, from its normal genus, Bromeliaceæ. In the two last-named, and some contingent genera, the ovary is superior or free, while in Bromelia and others it is inferior; and hence the type has been subdivided into the *Bromelieæ*, or *Bromelidæ*, and the *Tillandsieæ* or *Tillandsidæ*.

(1223.) The Bromeliaceæ shew some similitude, especially by the habit of Agave, to *Yucca* and *Aloe* contained in a preceding order. As a type, they are distinguished from the others in the same section by having only the three internal pieces of the perigonium delicately petaloid; the three external being herbaceous, and peculiarly harsh and rigid. The six stamens will likewise distinguish the Bromelidæ from Iridaceæ, and other sections in which the ovarium is inferior; and the Tillandsidæ, in which the ovarium is superior, are well known by the three-celled, many-seeded berries or capsules, and the farinaceous albumen of the seeds, as well as by the distinction of perigonium into calyx and corolla, which contrasts these latter with the Amaryllaceæ, to which they are otherwise allied. The similarity of the leaves of Bromelia, Ananassa, &c. to Stratiotes and Pandanus, cannot escape the least observant: it is one of the many links which associate the different provinces of the vegetable world.

(1224.) *Tillandsidæ*. As some few of the Liliales prefigure the characteristic development of this order, by having the perianth adnate to the germen, so some few of the genera included among the Musales reflect, or relapse into, the structure which is chiefly differential of the Liliales. Of this the Tillandsidæ afford an apposite example; for, although associated with the Bromeliaceæ, their perianths are free and fruit superior.

(1225.) *Buonapartea, Guzmannia, Tillandsia,* and the other genera included in this subtype, are all either elegant or very curious plants: the first, named after Napoleon the emperor, has little besides its external shewy appearance to recommend it. The Tillandsiæ, dedicated to the memory of Elias Tillandsius, professor of physic at Abo, and author of the "Flora Aboensis," are much more intrinsically important.

These curious plants, one of which *(Tillandsia utriculata)*, the wild pine of the colonists, is a native of Jamaica, and of the greatest service to the inhabitants of that hot climate, either during their journies into the woods, or in any scarcity of water: for its leaves are channelled, three feet long and upwards, and enclosed within one another, so as to convey all the water they catch upon their expansions down to their bases, which swell out and form a reservoir, or bottle, so contracted towards the neck, that evaporation by the heat of the sun is in a great measure prevented. The basins or cisterns formed by the concave inner surfaces of the leaves will each hold about a quart of water, which, although primarily designed for the sustenance of the plant, is found to afford very seasonable supplies to both men and animals. Birds and insects come in troops to these vegetable tanks, and travellers apply to them for relief. Dampier, in the account of his travels, says, "The wild pine is a plant so called because it somewhat resembles the bush of leaves which surround the true pineapple. The wild pines commonly grow from some bunch, knot, or excrescence of a tree, where they take root, and spring upright. The root is short and thick, from whence the leaves rise up in folds one within the other, spreading often to the top of the tree. They are of a good thick substance, and so compact as to catch and hold the rainwater when it falls. They will contain a pint, or a pint and a half, or a quart, and this water refreshes the leaves and nourishes the root. When we find these pines," continues our traveller, "we stick our knives into the leaves, just above the roots, and let out the water, which we catch in our hats, as I have done many times myself, to my great relief."

The seeds of these plants are furnished with long pappose hairs, which, streaming in the wind, attach the seeds, when borne away, to the branches of the trees on which they are to grow; for the Tillandsiæ are parasites, and without some such contrivance their seeds would be cast on the ground, and never be conveyed to the only soil on which they can flourish.

(1226.) Another species, likewise a native of Jamaica, which, from its resemblance to *Usnea*, the old *barba Jovis*, or tree-beard, has received the name *T. usneoides*, is a very curious plant. Its stems are pendent, no thicker than threads, often curled, and hang down from the branches of the ebony trees like tufts of hair, a yard long. Within these stems there is found a tough black filament, no thicker than a horsehair. These parasites are collected, and exported from Jamaica to North America, for the use of upholsterers, saddlers, and coachmakers, who use them, when prepared, instead of horsehair to stuff seats, cushions, panels, mattresses, &c. The manufacture consists in tying the stems in bundles, and steeping them in water, or burying them in a wet place, until the outer and softer parts have rotted, so that they can be easily removed or washed away; they are then boiled until clear of the refuse parts, and substituted for horsehair, from which they are with difficulty distinguished, unless the branching of the fibres be accurately examined. The Bonana birds' nests, which are found suspended by a few

threads from the expanded branches of large trees, and especially such as grow over ponds or lakes, are said to be always made of the fibres of this plant.

(1227.) Bromelidæ. The genus Bromelia has lost much of its interest and importance since the pine-apple has resumed its original Peruvian name, *Nanas*, now latinized *Ananassa*. The various species are remarkable for their power of subsisting for a long period on the fluids they contain, or on what they can absorb from the atmosphere, without any communication with the earth. Hence they are favourites with those who patronize hanging gardens, and in Mexico are commonly suspended to the balconies, for the sake of filling the houses with their delightful fragrance. Some of the Bromeliæ are planted as hedges, and the leaves of others, as the Grewatha, are made into ropes.

(1228.) The pine-apple (Ananassa), which by common consent is esteemed the most excellent of fruits, has not been known in Europe above two hundred

Ananassa sativa.

Ananassa sativa [olim *Bromelia ananas.*] *(a)* Foliage and inflorescence. *(b, c)* Bractea investing the flowers and fruit. *(d)* Section of flower, to shew the inferior germen, stamina, and pistil.

years, and not cultivated in Britain for more than a century. But at the present time pines may with more certainty be procured any day in the year in London, than in their native country, and, it has been asserted, of a finer flavour. The fruit of this plant is compound, and consists of numerous concrete ovaria, blended into a common mass with the adnate perianthia become succulent. The malic and citric acids, which give to the pines, when they are fully ripe, their exquisite flavour, are so abundant before maturity, that the unripe juice is said to have even caustic properties; and at all times is so powerful as to corrode the knives with which the fruit is cut. In tropical countries pines are recommended in diseases of the kidneys, but, although a most pleasant form of medicine, the cost will prevent its frequent exhibition here.

Pines are chiefly propagated by suckers, and, from the crown or tuft of leaves which surmounts the mass of fruit, and which is a continuation of the general axis, prolonged after the development of the flowers, and this, when planted, grows, and forms in time another mass of flowers and fruit: by proper treatment, this elongation of the axis, and extension of the individual, may be carried to an indefinite extent.

(1229.) The different species of *Agave*, [§ 75, c,] especially the *A. Americana*, or American aloe, have long been favourite greenhouse plants in England, and have even been acclimated in the southern parts of Europe. Indeed, so essential an ornament is the American agave considered in Italy, that near Milan, and in other parts of Lombardy, where it will not endure the winter, imitations of it are made, and so well constructed and painted, that they are usually mistaken for real plants. The old and absurd notion that the Agave flowers only once in a century, is scarcely worth contradicting. Several have blossomed in the neighbonrhood of London within the last few years, and been made the subjects of public exhibitions. The slowness of the general growth of the foliage, and the rapidity with which these plants send up their flowering stem, (fifteen or twenty feet in height, within the space of a few weeks,) is a circumstance worthy observation. In the West Indies, and even in Spain, Portugal, and Sicily, hedges of Agave are common.

(1230.) A substitute for soap is made from the leaves of the Agave Mexicana, by expressing the juice, and boiling it to a proper consistence. This soap, it is said, will wash as well with salt as with fresh water, but must not be mixed with oil or other fatty matter. The fibrous structure of the leaves of these plants, when prepared, by bruising and steeping them in water, are converted into thread, which is made into cords, and various kinds of coarse cloths.

(1231.) The Agave Americana abounds with sap, which flows freely from wounds made either in the roots or the leaves, even for months together. This sap contains much sugar, which is converted into syrup, or obtained in a solid form, by evaporation. When allowed to ferment, this juice becomes changed into a sort of wine called *pulque*, but large quantities are consumed in an unfermented state; the plants being tapped, and bucketsful carried to the markets daily.

(1232.) AMARYLLACEÆ, or NARCISSACEÆ. *Narcissus, Amaryllis, Galanthus, Leucojum*, and the other genera included in the type called indifferently either *Narcissaceæ* or *Amaryllaceæ*, afford another series of beautiful gradations in the change of the floral integuments into what Linnæan botanists term a *nectary* (nectarium.)

(1233.) Nectary is a word invented by Linnæus, and conveniently employed to designate a further change of the parts of fructification beyond that which gives the normal character of calyx or corolla, and yet when the so far developed parts have not assumed the form or functions of stamina or pistils: hence nectaries are usually scales, or filaments, but frequently undeveloped or only half evolved petals or stamens are included, and sometimes especial organs are discovered. Thus in the snow-flake, *Leucojum*, all the six pieces of the perigone are equally developed,

but in the snow-drop, *Galanthus*, the three internal are small and emarginate, and have been sometimes, though improperly, called nectaries; while in Narcissus, besides the six pieces highly coloured that form the perigone, there is a cup or crown which constitutes a Linnæan nectary [§ 75, E.] In cultivated flowers this cup or nectary is often resolved into a whorl of additional petals, occasionally into a whorl of additional stamens, and in Gethyllis, which is a polyandrons genus, this metamorphosis is constant. The nectary, however, is not always a separate organ, for as the sepals and petals are often confounded together and indistinguishable, so likewise the nectary is often a part of the calyx or corolla, and is sometimes not separable from them.

(1234.) The *Amaryllaceæ*, like several of the contingent sections, have the axis abortive or nearly so, and the caudex contracted into a plate (lecus), whence a tuft of leaves arise, the bases of which becoming succulent constitute a bulb. Hence most of the genera here associated are bulbous plants; in some, however, as Clivia, Doryanthes, and Alstroemeria, the axis descends at once without forming a plate, and divides into numerous rootlets. The foliage of these plants is radical, the leaves somewhat sword-shaped and with parallel linear veins; the flowers are generally enclosed in a large bracte or spathe, but sometimes several bracteæ terminate the flower-stalk, when the inflorescence is in a sertulum or simple umbel. The perianth is six-parted, and the corollaceous sepals equitant in æstivation. The stamina are six in number, either free or monadelphous; the germen is inferior, three-celled, and generally many-seeded; the fruit a capsule or berry, which occasionally by abortion is only one-celled; the style is simple and the stigma either simple or three-lobed; the seeds have either membranous or crustaceous testæ, and contain a cylindrical embryo included in a fleshy albumen.

(1235.) The genera associated to form the type *Amaryllaceæ* have been distributed into two subtypes or subordinate groups, in one of which the seeds have black crustaceous testæ and a rostellate hilum; in the other the seed-coats are soft and spongy, and the seeds beakless. *Hypoxis* is the normal genus of the former, Amaryllis of the latter group, which hence are called the *Hypoxidæ*, and *Amaryllidæ*.

(1236.) Collectively considered the *Amaryllaceæ* are hexapetalous Narcissinæ with six or more stamens, and with ensiform, non-equitant leaves: the above characters are therefore both their associating and differential signs.

(1237.) *Hypoxidæ*. *Hypoxis*, withdrawn from *Asphodelaceæ* by Dr. Brown on account of its inferior ovarium, seems to be a link of connexion between them and the *Amaryllaceæ*, with which it is combined by Richard, and from which it very slightly differs; the hard dark brittle testa, to the seeds and indehiscent capsule, being the chief marks of distinction of the subtype *Hypoxidæ*. The foliage of these plants is plaited, harsh, and rigid, which circumstances seem to argue them distinct from both *Amaryllidæ* and *Asphodelaceæ*, and hence they are admitted as a subtype, although a more distant separation does not seem advisable. *Hypoxis*,

Curculigo, and their very few allies at present known, are natives of New Holland, the East Indies, the Cape of Good Hope, and

Hypoxis stellata.

A. Entire plant.

(*a*) Pistil.

(*b*) Fruit of H. decumbens.

(*c*) Transverse section of the fruit.

(*d*) Seed.

(*e*) Section, to shew the included embryo.

North America. They are plants of little beauty, *H. stellata* excepted; and hitherto unapplied to any useful purpose.

(1238.) *Amaryllidæ.* Amaryllis, Hæmanthus, Nerine, Bruns-

Alstroemeria pulchella.

Cutting in flower; stamens and pistils denuded; with pieces of the petaloid perianth.

vigia, Galanthus, Leucojum, Crinum, Pancratium, Narcissus, Alstroemeria, and the numerous other genera included in this subtype, are among the most ornamental plants of our gardens

and conservatories. They are likewise remarkable for the acrid or poisonous properties of the majority, associated as they naturally are with other types and sections, in an order and a series of classes celebrated for the abundance of wholesome food they furnish, and the prevailing absence of deleterious qualities.

The narcotic odour of the Narcissus was known to the ancients, indeed its name is said to be derived from (ναρκη,) stupor; and hence it was one of their funereal flowers. The smell of many is, however, exceedingly grateful; but in confined apartments their exhalations are reputed to be noxious. The bulbs of these plants abound more or less in farina, containing an emetic principle, which in some, as the N. poeticus, N. Jonquilla, &c. is so predominant, that they were called *bulbi vomitarii* by the older herbalists. *N. odorus, Pseudo-narcissus*, and *Tazetta,* have similar properties, and are administered on the continent in doses of five or ten grains to produce nausea, and thirty grains as an emetic.

The extract is the best form in which the active principle of the Narcissi can be exhibited medicinally. Two or three drachms of this preparation will destroy life in the course of a few hours. In doses of two or three grains, it is regarded by some persons as almost a specific in hooping-cough. But Laennec says, in speaking of its effects in pertussis, "I have used this extract much, and have occasionally seen it effect surprisingly rapid cures; for instance, in five or six days; but this result is rare, and as a general remedy I find it much less efficacious than Belladonna.

(1239.) The different species of Amaryllis are more or less poisonous, and *Hæmanthus toxicarius,* the old A. toxicaria, is the plant with which it is said the Hottentots poison their arrows. Weapons wetted with the juice of the bulb convey certain death by the slightest wound; dissolution is preceded by violent struggles, and efforts to vomit. The flesh of animals thus slain is not deteriorated, but is eaten by the natives. *Nerine sarniensis,* the Guernsey lily, which became naturalized in the islands of Jersey and Guernsey many years ago, by the wreck of a vessel from the Cape, is also reputed to be poisonous. Amaryllis ornata is said to be astringent; *Alstroemeria salsilla* is considered useful as a diuretic and diaphoretic: and A. Ligtu is esteemed for its scent, it being as grateful as mignionette. A. salsilla is cultivated in the West Indies and in America, especially in Peru, for the sake of its roots, which are there eaten as the tubers of the potato are in Europe. It is worthy of note that the Amaryllidæ lose much of their fragrance when the flowers become double, which is precisely the reverse of the multiplication of the petals in Rosaceous plants.

(1240.) BURMANNIACEÆ. Certain exotic genera, such as *Burmannia* and *Maburnia*, with *Hæmodorum* and *Dilatris*, *Barbacenia* and *Wachendorfia*, which, although transitional between *Amaryllaceæ* and *Iridaceæ*, would form exceptions to the characters of those types if included in either, have been associated into two small groups or subtypes, the *Burmannidæ* and *Hæmadoridæ*, which form, together, the type BURMANNIACEÆ.

(1241.) Differentially considered, the *Burmanniaceæ* are tri- or

hexapetaloid Narcissinæ with mostly equitant leaves, æstivation rarely equitant, the tube of the perianth either winged or hairy, and the stamens in general six, rarely many, and if reduced to three, placed opposite the internal pieces of the perianth.

(1242.) Those genera in which the stamens are variable in number, the anthers introrse, and the perianth pilose, are associated to form the subtype *Hæmadoridæ*, while those in which the flowers are triandrous, the anthers dehiscent transversely, and the perianth angled or winged, constitute the subtype *Burmannidæ*.

(1243.) Hæmodoridæ. *Hæmodorum*, *Dilatris*, and *Lanaria*, with *Vellozia*, *Barbacenia*, *Xerophyta*, and other exotic genera which form the present subtype, are tri- or hexapetalous *Narcissinæ*, with the tube of the perianth externally covered with hairs or wool, and the æstivation rarely equitant, the stamens three, six, or more in number, (if only three, opposite the internal segments of the perianth,) the anthers two-celled and introrse, the germen inferior, in all except Wachendorfia, the fruit capsular, the seeds with smooth membranous or coriaceous testæ, the albumen cartilaginous or fleshy, and the embryo small and remote from the hilum.

The *Hæmodoridæ* are herbaceous perennial plants, with fibrous or fasciculated fibrous roots. Often with the superior axis abortive, the leaves alternate, ensiform, and mostly equitant. They are chiefly stemless, but the Velloziæ have dichotomous trunks and tufted leaves. This subtype is evidently transitional, the variable number of stamens connecting it both with *Iridaceæ* and *Amaryllaceæ*, the equitant leaves with the former, and the occasionally equitant æstivation with the latter. The *Hæmodoridæ* are many of them handsome shewy plants; the roots of several, as *Dilatris tinctoria*, *Hæmodorum*, and *Wachendorfia*, yield a red dye; but they are not of any great economical importance.

(1244.) Burmannidæ. If separated from the *Hæmodoridæ* or *Iridaceæ*, with both which and Bromeliaceæ they are connected, the genera *Burmannia* and *Maburnia* will form a very small and unimportant group, chiefly characterized by the transverse dehiscence of their adnate anthers, and their three stamina being opposite the interior pieces of the perianth, by which, although associated to *Hæmodoraceæ*, they are distinguished from *Iridaceæ*. Jussieu placed the genus Burmannia among the Bromeliaceæ, Martius has pointed out its affinity to *Hydrocharinæ*, and Bartling to *Hypoxidæ* and *Hæmodoridæ*, with which it is here conjoined in a com-

mon section. They are homely-looking plants, the properties of which have not been investigated, and the uses, if any, are at present unknown.

(1245.) IRIDACEÆ. The *Iridaceæ* or flowering-flags, including *Crocus*, *Gladiolus*, *Iris*, *Tigridia*, and numerous other allied genera, are plants of peculiar interest, as to the modifications of structure they present both in the organs of vegetation and fructification.

(1246.) The intermediate caudex of the crocus, which is usually considered as a solid bulb, is rather a rhizoma, from the bottom of which the roots proceed, and upon which the buds are situated; this axis neither lengthens upwards nor downwards to any considerable extent, for the buds separate and the old rhizoma perishes; but in Iris this rhizoma is not subterranean but prostrate on the surface of the soil, and each successive yearly growth, instead of dying, continues to connect the foregoing which have been formed by the successive crops of buds, and thus produces a mass of stem of considerable extent, sometimes simple, and sometimes, according as more or fewer buds are developed, variously branched; and this rhizoma, which in the iris is naturally prostrate, may be considered as a forerunner of the elevated stems of palms; and accidentally prostrate palms, as Elais melanococca, [§ 1081,] which send out inferior radicles, confirm the likeness; the internal structure of the one is also equivalent to that of the other.

(1247.) The foliage of crocus embraces the stem much less than the leaves of iris and sisyrinchium, which, with others like them, are said to have *equitant* foliage; and these equitant leaves, when the culm raises the flower, are converted into bracteæ, gradually becoming modified, and at last in the form of spathes enveloping the blossoms before they expand. In the genus iris the whole of the six pieces of the perianth are highly coloured, the three outer, which are reflexed and form the calyx, the most so; the three inner pieces are more erect, and constitute the corolla; within which are found three stamina covered by three petaloid pistils, which thus mark the transition of these organs into each other; the transition of leaves into bracteæ, and bracteæ into calyx and corolla, has already been noticed in several cases, *e. g.* Arum, Calla, Butomus, &c.

(1248.) The *Iridaceæ*, which form a very natural assemblage of plants, in all of which, excepting *crocus*, the leaves are equitant, rise in general from a rhizoma either extended as in iris, contracted as in crocus, or still less developed, as in those which have been described as having fibrous roots, *i. e.* where the inferior caudex is at once divided from the crown into fibres without forming even the plate of crocus, which is called a *lecus* if very thin, or a *combus* if collected into a thicker mass. The stamens in *Iridaceæ* are always three, while in the other associated orders they are generally six, the *Burmannidæ* and some few *Hæmadoridæ* only having three; but from these, as well as from all the other sections in this

district, the *Iridaceæ* are easily known by the outward dehiscence of their erect anthers. The germen is inferior and trilocular, the placentæ axial, the ovules many, and the albumen hard or horny.

(1249.) Those Iridaceous plants like *Iris*, [§ 75, D] *Crocus, &c.* which have the stamens discrete, form the subsection *Crocidæ*, while those which have them united or monadelphous, as Ferraria, Tigridia, Sisyrinchium, &c. constitute the second subsection, *Ferraridæ*.

(1250.) *Crocidæ*. Iris, Ixia, Gladiolus, Crocus, and their associates, although highly ornamental, are not very useful plants.

Saffron is afforded by the *Crocus*, which is the only genus having odorous stigmata. Good saffron should consist of the stigmata alone, and hence the number of plants required to produce even an ounce will sufficiently account for the high price this drug bears in the market. The diseases to which the Croci are subject, especially their liability to be attacked by that most destructive parasite the *Rhizoctonia*, the effects of which have been already described [§ 553], further enhance the value of saffron, and tempt fraudulent dealers to mix not only the stamina of the plants with the pistils, but also to adulterate the drug with the petals of the Carthamus tinctorius, the Calendula officinalis, and even the dried fibres of beef. These admixtures can easily be detected either by maceration, which will develop the form of the petals, or by burning a small quantity of the suspected sample, when, if dried flesh be present, it will be betrayed by the peculiar animal odour. Saffron is aromatic and stimulant, and is a favorite popular carminative; it is, however, chiefly now valued for its colouring matter, which is owing to a peculiar proximate principle called polychroite. The plants are grown in large quantities in many places. English saffron is esteemed more, and bears a higher price, than that of foreign growth. The chief saffron gardens used to be in the neighbourhood of Walden, in Essex, which hence obtained the distinctive appellation of Saffron Walden.

(1251.) Although crocus alone has aromatic stigmata, a great uniformity prevails among all these plants in the properties of other parts. Their fleshy rootstakes contain much fæcula impregnated with an acrid bitter principle; hence both Iris Germanica and pseudacorus have been employed as purgatives and emetics, and the I. florentina, from its agreeable odour, to make tooth and hair powder, and to keep up the discharge from issues. Pallas says that the roots of I. dichotoma are eaten in Siberia, and, according to Thunberg, the Hottentots roast and eat the roots of I. edulis; which Sparmann adds they call *Oenkjes*, and reckon their age by the number of their nodes. The seeds of I. pseudacorus, when roasted, form a very excellent substitute for coffee. *Iris fœtidissima* affords a curious example of the tastes and distastes peculiar to different men, for its odour is thought by most persons to resemble that of roasted beef or mutton, and can therefore scarcely be allowed to merit the Linnæan specific name of *fœtidissima*.

(1252.) *Ferraridæ*. *Ferraria, Tigridia, Sisyrinchium*, and the other Iridaceæ with connate filaments but distinct anthers, which are associated in this subtype, are not less, perhaps more, ornamental than even the Crocidæ. Their properties do not materially

differ from those of the preceding subtype. *F. cathartica* and *F. purgans* declare their powers by their titles, and the expressed juice of these plants is, according to Martius, given as an aperient in Brazil under the name of Field Rhubarb. Their chief interest, however, depends upon the connexion which their monodelphous structure establishes between the present section and the gynandrous *Orchidinæ*.

(1253.) Differentially considered, the *Iridaceæ* are triandrous *Narcissinæ*, with the stamens opposite the exterior pieces of the perianth, anthers extrorse and equitant, or rarely subequitant leaves.

SCITAMINÆ.

(1254.) The *Scitamenta* of the ancients were certain savoury and well-spiced viands, the elegant delicacies of the tables of those times; and hence Linnæus applied a kindred word to denominate

A. *Maranta arundinacea*, a cutting. (*a*) Flower separated. B. Flower of *Canna glauca*, to shew the trisepalous calyx, tripetaloid corolla, and the stamen with its dimidiate or one-celled anther; the filament and the other half of the anther case being petalöid. (*b*) Another view of the same. C. *Zingiber officinale*, shewing the rhizoma, rootlets, leaves, and spicate flowers. (*c*) The pistil running between the two-celled anther with the filament petaloid, in *Zingiber Casumunar*. D. Front view, and (*d*) side view of the two-celled anther in *Curcuma zerumbet*.

a group of plants in which are included some of the most sapid and grateful condiments known. But, besides the *Gingers* and the *Cardamoms*, the present section comprehends the *Musæ* or *Bananas*; and, thus extended, it has a further claim to the collective title *Scitaminæ*, as the original word was applicable to other elegancies besides those of taste.

(1255.) The *Scitaminæ* are often large herbs, and even tree-like herbaceous plants, with perennial, tuberous, or fasciculated fibrous roots. The stems are mostly round and simple, the axis being occasionally abortive; the leaves alternate, vaginant, and penninerved. The flowers united; the perianth superior, of six pieces and irregular; the outer three more or less sepaloid, the inner ones petaloid. The stamens six, one or more often becoming petaloid and barren, the anthers one or two celled, the pollen pulverulent, the germen inferior, three-celled or rarely one-celled, with central placentæ, seeds in general many, style simple, or rather triconnate, stigma simple or three-lobed. Fruit capsular, mostly three-celled and three-valved, rarely fleshy. Albumen farinaceous or horny; and the embryo cylindrical and included.

(1256.) Differentially considered, the *Scitaminæ* are therefore tri- or hexapetaloid *Musales* with an irregular perianth, inferior germen, central placentæ, and penninerved leaves.

(1257.) The banana (*Musa*), the ginger (*Zingiber*), and the arrowroot (*Maranta*), are the normal genera of three types, called from them *Musaceæ*, *Zingiberaceæ*, and *Marantaceæ*, which are associated in the section Scitaminæ. These groups form a very interesting series both in an economical and physiological point of view, as they afford for use much grateful food, and exhibit further examples of that gradual progression of changes already pointed out so frequently, in former sections.

(1258.) *Musaceæ*. The *Bananas*, though very distinct from the palms, still in the formation of their stipites, by the bases of their immense leaf-stalks [§ 1206,] and in the gradual abortion of true stem and the contraction of the stipes to a rhizoma, they shew the progression from the short-stemmed palms to the *Zingiberaceæ* and *Marantaceæ*, with which they are more closely allied.

The foliage of the Musaceæ likewise, although differing from the longitudinally divisible leaves of palms, is an example of true transition from the Phœnicinæ to the other sections of this class; for here the general axis or midrib lengthening after the expansion has ceased to grow, splits it into ribands in the direction of the secondary fibres at right angles with the midrib [§ 1206], which only differ in their direction from the lacerated portions of the flabelliform palms, in which the axis of the leaf may be considered abortive, and the ribands of the expansion exserted from the same point. Even in the direction of the lacerations they are identical with the Sago and the Date. In *Strelitzia* the foliar expansion is occasionally suppressed.

(1259.) The *Musaceæ* are spathaceous, as are likewise the majority of the palms; but they differ from them and most of the preceding sections in having the ovarium inferior and the tube of the calyx adherent to the germen, the flower of course being superior. The perigone is petaloid and often of the most brilliant colours, of three external and three internal pieces, which, although both coloured, differ like Iris in the degree of their development; the stamens are six in number, either all fertile, or the anther of one or more abortive, and the filaments surmounted with a petaloid appendage. In *Musa*, the normal genus, five of the segments of the perigone are external, forming an upper lip, and one only internal, which is the lower lip. The anthers are linear, introrse, and bilocular, dehiscing longitudinally. The germen three-celled, and the seeds with the embryo in the axis of a farinaceous albumen.

(1260.) *Musa, Urania, Heliconia,* and *Strelitzia*, are all most splendid plants, the leaf-formed stems varying from five or ten, to five and twenty, or thirty feet in height, and the leaves being each from two or three, to ten or twelve feet in length. In *Urania* [§ 1206] the leaves are disposed in a graceful fan-like spread, and those both of Musa and Strelitzia are even in our conservatories quite magnificent.

Strelitzia regina. Flowers arising from within a common spatha. A. Flower denuded of calyx. B. An entire flower, shewing stamens, pistil, and nectary; *f*, germen; *g*, corolla; *h*, nectary; *i*, stamens; *k*, pistil. C. Front view of a flower. D. Back view of ditto.

(1261.) The two most valuable and best known species of *Musa* are the Adam's apple or Plantain (*M. paradisaica*), and the Banana-plantain (*M. sapientum;*) the latter is a denizen of the New, the former of the Old World. Indeed, as the specific name *paradisiaca* imports, a notion was entertained by

the old botanists, as by Gerarde and others, that this was the forbidden fruit of Eden; while others, having regard to the immense grape-like clusters in which its fruit is collected, have supposed it to be the so-called grapes,—one bunch of which was borne upon a staff between two men—that the spies of Moses brought out of the Promised Land. It is not however at all likely, other considerations apart, that a plant so useful should have been the forbidden fruit. The Plantains and Bananas are well esteemed among the most valuable gifts bestowed upon the inhabitants of the hotter regions of the globe, and they have followed the footsteps of man to all countries where he has dwelt, in which the climate would suffer their growth.

Europeans who settle in America, and families as they separate and establish themselves by marriage as a first step toward their support, plant a Banana walk, which they extend as their family increases. Some of the Plantains are in bearing in turns during the whole year, and their fruit is often the whole, or the chief part of the food, on which the family subsists. Three dozen fruits are sufficient to serve one man a whole week instead of bread, and will support him in warm countries much better. When boiled or roasted, they are used in the place of bread, and eaten with fish or salt meat. When ripe, tarts are made of them, or the fruit is sliced and fried with butter, or dried and preserved as a sweetmeat, or converted into an excellent marmalade. An intoxicating liquor is also made from them by fermentation; and this drink, when procured from the M. sapientum, is, says Loudon, like our best Southam cider. The young shoots are eaten as a delicate vegetable.

(1262.) The fruits of some species of *Heliconia* and *Urania* are also eatable, as the *U. speciosa* and *H. psittacorum*, but they are not in such general estimation as those of the Bananas. The juice of the fruit of *Urania* is used for dying, and that of the fruit and stem of *Musa* is said to be astringent and diaphoretic. The leaf-formed stems are remarkable for the profusion of spiral vessels they contain, which may be pulled out by handfuls, and are used in the West Indies as tinder. *Musa textilis* affords a very valuable flax-like fibre, from which some of the finest Indian muslins are made. The leaves of all the species are likewise employed in the manufacture of baskets, matting, mattresses, thatching, and for numerous other similar purposes. The native Indians use them also as plates, dishes, and napkins; and those persons who believe the fruit to be the forbidden apple of Paradise, have also adventured the groundless surmise that the large leaves of plantain were the so-called fig-leaves of which our first parents made their aprons.

(1263.) Differentially considered, the *Musaceæ* are spathaceous *Scitamineæ*, with a hexapetaloid perianth, and more than three fertile stamens.

(1264.) Zingiberaceæ. *Zingiber*, [§ 1254, c, d] and its allies, *Amomum*, *Costus*, *Alpinia*, *Curcuma*, *Kæmpferia*, &c. form, collectively, the type *Zingiberaceæ*; of which the tripetaloid perianth and single median fertile stamen, with a two-celled anther, and the embryo surrounded by the vitellus, are the chief differential signs. Almost the whole of the Zingiberaceæ are aromatic plants; the

tuberous roots or root-stakes abounding in spicy juices; and the seeds of many are aromatic also.

(1265.) In the *Zingiberaceæ* the leaves are simple with longitudinal linear veins, like those of the Musaceæ, but more obliquely penninerved; the petioles still clasp the bases of each other, and form a sort of culm similar to the *Bananas,* and, like them, the true stem or stipes in this section is prostrate or subterranean, and is often called the root, as in *ginger.* The leaf-sheaths are cleft, and sometimes furnished with a ligule; the inflorescence is in spikes or racemes, rarely solitary, with spathaceous bracteæ; the perigonium is in two rows, the inner more developed than the outer, and petaloid, with one segment often larger than the others. The corolla is tubular and irregular, and within it are three petal-like productions, forming a nectary, which are equivalent to those of the six stamens of Musaceæ, degenerating into petals; one segment of the nectary is larger than the rest, and lip-like, the lateral pieces being often almost or altogether abortive. Within the nectary are three stamina, one only of which is perfect, with a two-celled anther; the others are on each side abortive, assuming the appearance of glands, and sometimes connate. The pollen is light, granular, globose, and smooth. The germen three-celled (rarely one-celled,) style filiform, stigma hollow and dilated. The fruit is capsular, rarely sub-baccate, and trilocular. The seeds roundish or regularly angled, and sometimes arillate, and containing a cylindrical embryo surrounded by a *vitellus,* and enclosed in a farinaceous albumen.

(1266.) *Amomum,* the genus in which most of the aromatic Scitaminæ were formerly included, and from which the present type is sometimes called the *Amomeæ,* has been very much reduced in extent since the reformation of the order effected by Roscoe. Ginger and Cardamom now belong to other genera, and the *Grana Paradisi* is almost the only species that justifies the retention of the generic name Amomum (*α μωμος*), *anticorruptive* or *counter-poison,* these plants having been once considered preventives of putrefaction and antidotes to poisons.

(1267.) The grains of Paradise are stomachic and stimulant, but far less grateful as a spice than either cardamoms or ginger; they are often, however, substituted for the former, and have even been called the 'greater Cardamom.'

(1268.) The officinal Cardamom is the fruit of the *Alpinia cardamomum;* and it is much valued as a condiment in warm countries. Here the seeds are chiefly used as medicines, and in dyspectic cases render considerable service. The *Galangales* (Kæmpferiæ), the *Zedoaries* (Cucuma Zedoaria and Zerumbet), are also esteemed as spices, and several others, such as *Curcuma longa* (or Turmeric), which is also aromatic, afford excellent dyes. *Turmeric* is one of the constant ingredients with ginger, cardamoms, and the like associated spices, in the celebrated curry-powders of the East and West Indies.

(1269. The rhizomata of all the Zingiberaceæ contain fæcula, which, however, is rendered unfit for ordinary food, and can only be used as a condiment by the quantity of pungent, resinous, and aromatic oily matter it contains; in some, however, as Curcuma angustifolia, the spicy flavour is lessened, and from it an excellent kind of arrow-root is prepared.

(1270.) Marantaceæ. *Maranta,* and its allies, *Thalia, Myrosma, Phrynium, Calathea,* and *Canna,* [§ 1254, A, B.] con-

stitute a type called, indifferently, MARANTACEÆ or Canneæ, which is differentially characterized by having the stamina reduced to one, the others being petaloid, and this single fertile stamen being lateral and having a dimidiate or one-celled anther, seeds exarillate, and the embryo not enclosed in a sac, the vitellus being absent.

Canna flaccida. (*a*) Cutting, to shew penninerved, or pennicostate leaf, and flower.

(*b*) Ovary with the adherent calyx.

(*c*) Corolla open, shewing the one-celled anther.

(*d*) The fruit.

(*e*) Transverse section of ditto, to shew the three cells.

(*f*) A seed, shewing the opercle and the embryo.

(*g*) Section of ditto, to shew the embryo.

(*h*) The embryo enlarged, to shew the coleorhize and radicle.

(*i*) The seed germinating.

1, The testa, including the nucleus; 2, the raised operculum; 3, base of the cotyledon; 4, the præmorse radicle; 5, the primordial leaf.

(1271.) The Marantaceæ are scentless, insipid plants, the pungent aromatic principle being wanting in them which is so peculiarly characteristic of the Gingers and their allies. Hence the fecula which is abundant in their roots is collected and prepared as food, and, from its former use as a cataplasm for arrow-wounds, it is commonly known under the name of arrow-root. This farinaceous substance is procured from many different species, but chiefly from Maranta arundinacea in the West, M. Allouya and ramossima in the East Indies; the tubers of M. Allouya are also eaten entire when roasted, and the rhizomata of several Cannæ are used as food in Peru. Baskets are likewise made from their leaves, and the tough fibres they contain are applied to various domestic purposes.

(1272.) The Marantaceæ have frequently been confounded with the Zingiberaceæ, and they are in many respects closely allied to them, but still they are clearly distinguished by having their single anther one-celled, the other cell having degenerated into a petaloid production of the filament, and the stamen lateral. The style also is not threadshaped, but either tumid or petaloid, and in the seeds the vitellus is abortive, so that the embryo is covered only by the perisperm or albumen. This series of natural metamorphoses, in which the six stamina of Musaceæ pass from five to one in Zingiberaceæ, and that one losing one cell of its anther in Marantaceæ, and varying as they do as to which stamens are abortive, in Zingiberaceæ the central one being fertile, and in Marantaceæ

one of the side stamens being that which bears half an anther, leads the student to the contemplation of another very curious and natural series, contingent with these, but in the following section, viz. the orchideous plants, in which the changes are still more extraordinary than in the SCITAMINÆ.

ORCHIDINÆ.

(1273.) The plants associated with *Orchis* in the section called from it [Orchideæ or] *Orchidinæ*, exhibit some of the most curiously interesting modifications of structure that any groups in the vegetable world afford; and hence several of these transformed organs have received peculiar appellations.

(1274.) The Orchidinæ are chiefly perennial and herbaceous plants, some few only being suffrutescent, and in many the stem is obsolete; but to the crown of the root one, two, or more fleshy tubers are attached, [§ 3, *b*, *e*, *h*,) which contain the buds that are to form the plants of the succeeding year; in others the tubers are fascicled; and in others again, as the Aerides, or air-plants, the above-ground stem is enlarged and succulent, and the roots tortuous, caulescent, and of a green hue: many of them are epiphytic, as the Epidendra and Vanillæ.

The leaves of the whole section are simple and entire, alternate, either sheathing or articulated, with nervo-striated venation, and occasionally degenerating into scales.

(1275.) The perigonium consists of six pieces, mostly petaloid, and arranged in two series, [§ 3, *a*, *d*, *g*;] the sepals of the calyx are in general similar to each other, the odd one being uppermost; the petals of the corolla vary in form; the upper petal, which by the twisting of the ovarium becomes apparently the lower, is called the *lip* (labellum), as the two lower sepals, which become from the same cause uppermost, are named the *helmet* (galea). The lip, or labellum, which is often lobed, and assumes a great variety of grotesque forms, likened to flies, bees, men, and monkeys, [§ 3, *c*, *f*, *g*, *h*, *i*,] has been called by some persons the nectary. The stamina are three in number, becoming by abortion two or one, and, united with the pistil, forming a fleshy column, called the *gynosteme*, which surmounts the ovary; and hence these plants have been termed *epigynous* by Jussieu, and *gynandrous* by Linnæus. On the apex of the gynosteme there is found, in the Orchidaceæ, a two-celled anther, and on either side an eminence *(staminodia,)* marking the abortion of the other two, which remain in a rudimentary state in all the type, named, from *Orchis*, the ORCHIDACEÆ, and which are placed by Linnæus in his order Monandria of the twentieth class.

(1276.) In *Cypripedium*, or the lady's slipper, the stamens, which are abortive, as *Staminodia* in the Orchidaceæ, become developed, and the centre anther remains abortive as a staminodium, which circumstance characterises the second type, called, from the only genus it contains, the CYPRIPEDIACEÆ.

This curious plant will be found in Gynandria Diandria of the Linnæan artificial scheme.

(1277.) Before the single anther in Orchideaceæ, and rather before and between the two anthers in Cypripediaceæ, there is a secreting cavity, which is the naked stigma of the pistil, the other part of which is blended with the stamens in the

gynosteme. The pollen contained in the anthers is sometimes pulverulent and free, but more frequently waxy or granular, with the grains cohering in masses, which are called *sectile* masses: these have often prolongations, called *candiculæ*, by which they are attached to a viscid gland, that has been named the *retinaculum*.

(1278.) Occasionally the Staminodia betray their metamorphosis, and become fully developed as stamens; an instance of which has been mentioned by Achille Richard, as having been observed in *Orchis latifolia;* and others are noticed by Brown, in his essay on those plants published in the Transactions of the Linnæan Society.

This phenomenon, casual in the Orchides, appears to be the permanent and normal state in a genus allied to the Orchidaceæ, and named by Blume *Apostasia;* for in it the three stamens are developed, and the anthers free, one being barren.

(1279.) This very interesting genus, figures of two species of which have been published by Dr. Wallich, in his "Plantæ Asiaticæ Rariores," establishes the connexion between this section and the contingent ones in a manner the most satisfactory and unexpected. But although, without doubt, Apostasia belongs to the section Orchidinæ, it cannot be included in either of the established types, and must therefore be considered the normal genus of another, which may be called Apostasiaceæ.

The fruit in the Orchidinæ is capsular, rarely baccate, the placentæ parietal; seeds small and many; the testæ lax, reticulated, and membranaceous, with embryo minute, and not distinct from the albumen.

(1280.) Their reversed gynandrous flowers, inferior ovaria, and usually coherent pollen, will sufficiently distinguish the *Orchidinæ* from every other section, and furnish excellent differential characters.

(1281.) The three types are distinguished among themselves by the first, the Orchidaceæ, having the flowers monandrous, and the germen unilocular.

(1282.) In the second, the Cypripediaceæ, the flowers are diandrous, and the germen still one-celled.

(1283.) While in the third, the Apostasiaceæ, the flowers are diandrous or triandrous, the anthers discrete, and the germen trilocular.

(1284.) Apostasiaceæ. Three species of *Apostasia* are all that have been as yet discovered, and these are plants the properties and uses of which are very little known. Their chief interest depends upon the structural gradations they exhibit, by which the Orchidaceæ and Cypripediaceæ become associated with the Iridaceæ, Zingiberaceæ, and Musaceæ of the contingent sections. Thus, in *Musaceæ* the stamens, and in *Iris* the pistils, are petaloid; in

Zingiberaceæ the stamens are reduced to one, and in *Marantaceæ* even the single stamen has only a one-celled anther. Thus also in *Apostasia*, in which three stamina, the normal number in the *Orchidinæ*, are alone developed, the anther is absent from one

A. *Apostasia Wallichii*. (*a*) Entire plant, shewing its caulescent roots, alternate sheathing, nervo-striated leaves, and flowers. (*b*) A flower separated. (*c*) The same dissected, to shew the six pieces of the regular petaloid perianth, the style and stamens. (*d*) The style and stamina denuded. (*e*) An entire flower, fully expanded in order to exhibit the internal parts *in situ*. (*f*) The capsule, nearly ripe, divided transversely to shew the three cells. (*g*) A stamen detached. (*h*) Pollen. (*i*) Style, with the barren stamen reflected to shew the indications of the two cells of the abortive anther. (*j*) Seeds; one being divided longitudinally, the other entire.

B. *Apostasia nuda*. (*a*) Entire flower, shewing the hexapetaloid, regular perianth, inferior germen, stamen, and pistil. (*b*) Stamen detached. (*c*) Pollen. (*d*, *c*) Different views of the style, with corresponding plans, shewing the relative position of the parts of the flower.

C. *Ophrys apifera*, side view, to shew the single fertile stamen, two staminodia, and (*a*) a sectile mass of pollen with its *caudicula*.

filament, as in *A. Wallichii;* while in *A. nuda* the barren stamen is altogether wanting. In *Cypripedium* two stamens only are fertile, one being abortive; and in *Orchidaceæ* two are abortive, one alone bearing a fertile anther.

(1285.) Cypripediaceæ. *Cypripedium Calceolus* is one of the rarer British plants, and the most beautiful of the European

Orchidinæ; it is innoxious, and slightly nutrient. A decoction of its roots has been commended by Gmelin in cases of epilepsy, but their influence in that disease is more than apocryphal.

Cypripedium flavescens.

B. Entire plant, shewing fibrous root, amplexicaul leaves and flower.

(*a*) Front view.

(*b*) Side view of the stamens and pistil.

(*c*, *c*) Well-developed lateral stamens.

(*d*, *d*) Terminal or third stamen, abortive.

(*e*, *e*) Stigma.

(1286.) Orchidaceæ. *Orchis*, and its allies, are associated, by their monandrous flowers and unilocular ovaria, to form this type, which, from the normal genus, is called the Orchidaceæ. It contains the bulk of the orchidinous plants, the other two groups being each formed of only a single genus.

(1287.) The genera included among the Orchidaceæ being many, it has been found advisable to distribute them into several subtypes, distinguished by the different states of the pollen.

(1288.) In *Limodorum*, *Epipactis*, *Pogonia*, *Goodyera*, &c., which form the Limodoridæ, the pollen is pulverulent and simple, or formed of a kind of pultaceous matter in a lax state of cohesion.

(1289.) In *Orchis*, *Ophrys*, *Satyrium*, *Serapias*, *Habenaria*, *Vanilla*, &c., which form the subtype Ophrydæ, the pollen is in sectile masses or coherent granules, which finally become waxy, and are indefinite in number.

(1290.) In *Malaxis*, *Epidendrum*, *Vanda*, and others, which form the Malaxidæ, the pollen is in coherent grains, definite in number, and becoming waxy, and often being solid.

(1291.) The Orchidaceæ are more prized for their beauty and the strangeness of their flowers, than for any very important dietetic or medicinal properties they possess. When the doctrine of signatures prevailed, their geminate roots were supposed to be powerful aphrodisiacs, and hence the names Orchis, Satyrium, Serapias, &c. have been given to various genera; but it is probable that no quantity would induce that kind of madness which characterised the Roman demigods, or the devotees of the more profligate Egyptian divinity.

(1292.) The tubers of these plants contain a great deal of very nutritious farinaceous matter, consisting, according to modern chemical analysis, of a proximate principle called Bassorine. This substance is known commonly as *saloop*, or *salep ;* a word derived from the Persian name of the Orchis, which, according to Forskhall, is *Sahleb*. It used to be sold at the corners of the streets in London, and was a favourite drink with porters, coalheavers, and other hardworking people; and it is still highly esteemed both in Turkey and in Persia. It is said to contain more nutritious matter in proportion to its bulk than any other known substance, and that an ounce a-day will be sufficient to sustain a man: hence it is a favourite food, from its portability, with pedestrian travellers in wild deserts and uninhabited countries.

(1293.) Some of the South American species, such as the *Cataseta* and *Cyrtipodia*, contain a viscid substance, which, when separated by boiling and inspissated, is used by the Brazilians instead of glue. The root of *Bletia verecunda* is said to be stomachic, and *Orchis abortiva*, and others, slightly astringent.

(1294.) *Vanilla* is the produce of the *V. aromatica*, the old Epidendrum Vanilla. This plant is a climbing epiphyte, growing in the West Indies, and its root is used for flavouring chocolate, and also for perfuming snuff.

(1295.) The *Epidendra*, *Aerides*, and many others of the epiphytic species, (for they are not truly parasites,) are familiarly known as air-plants. They absorb much of their food from the atmosphere, and hence require very little either soil or water; so that, when taken from the trees on which they grow, just before their flowers are developed, and suspended by strings from the ceiling of a room, they will live for weeks, and even months, supported solely by the moisture floating in the atmosphere, and go on blossoming luxuriantly: hence they are some of the most favorite and elegant ornaments of the houses in China and Japan.

(1296.) Dr. Brown's observations on the structure of *Apostasia*, its relation to the *Orchideæ*, and the connexion it establishes between this section and the *Scitamineæ*, bear the impress of so much physiological research, and so fully corroborate the views above given of the affinities of these plants, that their history would be incomplete, were his remarks omitted: they are therefore quoted almost entire from his MS. notes, as published in Wallich's Plantæ Asiaticæ Rariores.

"This very remarkable genus, founded on Apostasia Odorata, was first published in 1825, by Dr. Blume; but in 1821 a nearly related species was discovered in the valley of Noakote, in Nepal, by the plant collectors of Dr. Wallich, who, in his MS., which I have had the advantage of consulting, named it *Mesodactylis deflexa*.

"I have followed these two distinguished botanists in regarding Apostasia as belonging to, or at least as most nearly related to, Orchideæ. It exhibits, however, very few of those characters generally considered as essential to that family of plants. In its antheræ, pollen, style, and stigma, (all which parts are so remarkably modified in *Orchideæ,)* Apostasia does not materially differ, either in form, structure, or economy, from the more regularly flowered families of monocotyledons; and in its trilocular ovarium it is distinguished from all other genera of the order to which it has been appended.

"On the other hand, it agrees with Orchideæ in the structure, as far as I am able to ascertain, of its minute seeds; in the reduced number of stamina, and probably with some genera of the family in the order of their reduction; in the filaments being at the base connate with the lower part of the style; and in a great degree in habit. In endeavouring to estimate the importance of the several points of resemblance and difference here enumerated, with a view to decide on the degree of relationship Apostasia bears to Orchideæ, it is necessary to consider the relative position of the parts of the flower in that order, and also in Scitamineæ (Zingiberaceæ), the family most nearly allied to it.

"The relation of the stamina to the parts of the floral envelop in Apostasia is in the first place to be determined. The two antheriferous filaments which I have more particularly examined in the unexpanded flowers of Apostasia nuda appear to be opposite to the two lateral segments of the inner series of the perianthium; and the sterile filament in Apostasia Wallichii, and no doubt in A. odorata, is opposite to the interior segment of its outer series.

"Several years since I advanced the opinion, that in a complete flower, whose parts are definite, the number of stamina, and also of pistilla, is equal to that of the calyx and corolla united in dicotyledons, and of both series of the perianth in monocotyledons." *(App. to Denham's Travels.)*

It may further be observed that, in cases of reduction of pistilla, it is generally found that the remaining carpella, when more than one, but inferior in number to that of one series of the floral envelop, correspond in position with parts of both series, and, with very few exceptions, whether distinct or confluent, are all equally developed: stamina on the other hand, in cases of equal reduction, generally belong to one series only; or, if corresponding with parts of both series, are usually in different states of development, as they are here described to be in two species of Apostasia.

This appearance of part of the inner series of stamina has not hitherto been expressly remarked in *Orchideæ.* It is not improbable, however, that the same relation to perianthium exists in the lateral antheriferous stamina of *Cypripedium,* as well as in the sterile petaloid processes similarly situated in other genera, as in Diuris; and the third stamen of the inner series, still more altered in form, may be considered as present in certain New Holland genera, especially Glossodia, where this supposed stamen is placed within the labellum, but entirely distinct from it, in Epiblema, Pterostylis, and Chiloglottis, in which an analogous appendage, similarly situated, coheres in various degrees with that division of the perianthium; and perhaps it may be considered as indicated in all cases in which the labellum is furnished with a process, however minute, arising from its axis.

If the view here taken of the position of the lateral filaments in Cypripedium and Diuris be adopted, it may be remarked that indications of the two stamina

necessary to complete the number in Orchideæ, of those, namely, corresponding with the lateral segments of the outer series of the perianthium, have not been yet observed in the regular structure of any plant of the order. They have, however, been occasionally met with in the monstrous flowers of Habenaria bifolia: in more than one spike of which, I have found the greater number of flowers triandrous, the three anthers being equidistant, and placed exactly opposite to the three divisions of the outer series of the perianthium, the inner series of which remains in its ordinary state.

In Scitamineæ, the family most nearly akin to Orchideæ, the complete number of stamina may be considered very generally present: only one, however, is antheriferous; and this perfect stamen, instead of corresponding, as in Orchideæ, with the anterior segment of the outer series of the perianthium, is placed within the posterior segment of the inner series; the two remaining barren stamina of the same series being the epigynous glands, or filaments, existing in all the genera of this order except Costus; while the outer series of stamina, very differently modified, form the innermost or supplementary series of the perianthium.

Apostasia, in its trilocular ovarium, differs from all the genera of Orchideæ; but an analogous difference occurs in Scitamineæ, in which Globba is distinguished from every other genus, in having its ovarium unilocular, with three parietal placentæ; and in both these families it may be proved that the constituent parts of the compound ovarium, whether unilocular or trilocular, agree in position, or in their relation, to the divisions of the perianthium.

Lastly, Apostasia, in the state of the pollen, and its manner of application to the stigma, probably differs essentially from all Orchideæ, except perhaps Cypripedium, and possibly *Vanilla*.

HYDROCHARINÆ.

(1297.) The lily-frog-bit (*Hydrocharis*), and the water-soldier (*Stratiotes*), with the beautiful and interesting *Vallisneria*, form, collectively, a section called, from the normal genus, *Hydrocharis*, Hydrocharinæ. These plants are connected with the *Alisminæ* and *Nayadinæ* in several points, as their exalbuminous seeds, semipetaloid perianths, and watery habitats declare; they are however sufficiently distinguished from these, and all other sections of the orders *Juncales* and *Liliales*, by their inferior ovaries and superior flowers, by which they are associated with the Musales.

(1298.) The *Hydrocharinæ* are aquatic herbs, or herbaceous plants, with the stems usually abortive, and the leaves for the most part radical, sometimes crowded, at others remote, alternate, or verticillate; the expansion, when present, floating, but the foliage often degenerates into phyllodia, occasionally furnished with spinacules and sheathing. The flowers are spathaceous, and usually separate; the perianth developed in two series, forming calyx and corolla; stamens three, six, or more, with filaments free; germen inferior, and single stigma divided (rarely simple;) fruit dry or succulent, inde-

hiscent, one or more celled, and many-seeded; seeds erect and exalbuminous, testa membranaceous, embryo straight, radicle inferior, and plumula inconspicuous.

(1299.) Hence it will appear that, differentially considered, the *Hydrocharinæ* are aquatic tripetaloid Musales, with free stamina and exalbuminous seeds.

(1300.) The genera included in this section, although agreeing in the above characters, common to them all, and by which they are as much separated from contingent groups as allied to one another, have been very properly, on account of several peculiarities of structure, distributed by Link into three subsectional groups, or types, named respectively from the normal genera *Stratiotes*, *Hydrocharis*, and *Vallisneria*, the *Stratiotaceæ*, *Hydrocharaceæ*, and *Vallisneriaceæ*.

(1301.) The *Stratiotaceæ* have the flowers spathaceous, the calyx tubular, and the petals of the corolla discrete both in the stamineous and pistilline flowers; the fruit also is baccate (not capsular), and the leaves are sheathing and with a parallel venation.

(1302.) The *Hydrocharaceæ* are distinguished from both their compeers by the veins of the leaves, which in them are linear and unconnected, having here the parallel venation from base to apex traversed by lateral veins passing from one series to another. The pieces of the corollæ are also discrete, the calyx cleft to the base, and the fruit a leathery capsule, not a berry. (§ 1305.)

(1303.) The *Vallisneriaceæ* are known by the diclinious (often diœcious) flowers; the stamineous ones having the corolla synpetalous, while in the pistilline flowers the petals are discrete. The fruit is also a one-celled many-seeded capsule, with parietal placentæ. (§ 1306.)

(1304.) Stratiotaceæ. *Stratiotes*, which has been so named from its sword-shaped leaves and the fanciful military appearance of the plant, is a very ornamental aquatic. It remains submerged during the greater part of the year, but raises itself to the surface on special stalks during the season for fertilizing the seeds; a device of nature to meet and overcome difficulties, which is still more curiously exemplified in one of the following types. The foliage of Stratiotes is very similar to that of Bromelia, but the leaves in the latter are scaly, while those of the former are smooth.

(1305.) Hydrocharaceæ. *Hydrocharis Morsus Ranæ*, or the frog-bit, is the lesser water-lily of the old writers, and is still con-

sidered by Richard and others to be an associate of the *Nymphæaceæ*, but the relation is one of analogy rather than of affinity; these being monocotyledonous endogenæ, while the weight of evidence declares that the *Nymphæaceæ* are exogenous dicotyledons.

Hydrocharis is a highly ornamental water-plant, which will grow

Hydrocharis Morsus Ranæ.

A. Entire plant. (*a*) Stamineous flower. (*b*) Ditto, with two stamens only left. (*c*) Stamen detached. (*d*) Female flower. (*e*) Longitudinal section of ditto. (*f*) Fruit. (*g*) Transverse section. (*h*) Seed. (*i*) Nucleus cut lengthwise. (*j*) Ditto, a transverse section.

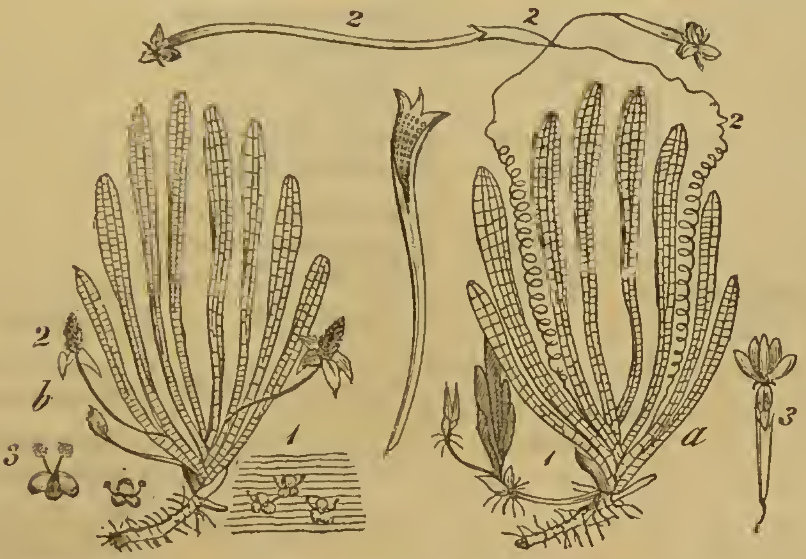
freely in ponds and ditches, and deserves to be more frequently introduced into aquaria.

(1306.) Vallisneriaceæ. Besides the differential characters of the type, the Vallisneriæ have the pistilline flowers elevated on spiral peduncles or footstalks; a structure almost peculiar to these plants, and to them of extreme importance.

The *Vallisneriæ*, unlike Hydrocharis and Stratiotes, which prefer still waters, delight to grow in rivers and rapid streams, where the level often varies one or two feet or more within the space of four-and-twenty hours. Now it is essential to the well-being of the plants, and to enable the ovules to be fertilized and the seeds to be ripened, that the flowers should, during the period of maturity, be kept on the surface of the water, and secured from frequent submersion. It so happens, from the peculiar structure of these plants, the stamens being distinct from the pistils, and even on separate roots, that the fertilization of the ovules is, as usual in such cases, difficult; and in this instance the difficulty of transferring the pollen from the anthers to the pistil is almost insuperably increased, by the stamineous flowers [*b*, 2] growing on short stalks below the water, while the pistilline ones [*a*, 2] are carried up by their specific levity and spiral peduncles to the surface. But these difficulties would seem to have been made only for the purpose of shewing with what admirable ingenuity they can be overcome. A particular example may be cited as an illustration: the Vallisneria spiralis grows in vast abundance in the Rhone, which is a river of very uncertain

depth, and that in places very near one another. The plants, during their propagation by runners or seeds, have therefore very different distances to pass

Vallisneria spiralis.



(*a*) Pistilline plant; 1, offsets; 2, pistilline flowers floating on the water supported by their spiral peduncles; 3, a flower separate. (*b*) Stamineous plant; 1, ditto flowers floating on the surface of the water; 2, ditto, attached to plant; 3, ditto opened, to shew the stamens.

through before they reach the surface of the water. But this is not all: the Rhone is also of all rivers the most apt to be swollen by sudden floods; and how is a plant flowering at the surface in four feet of water to avoid being submerged when the depth is suddenly increased to six feet? The spiral peduncles of the pistilline flowers are the mechanical means by which this object is effected, for as they gradually contract like a helix or wire-spring when the water falls, so on the other hand they are readily extended when it rises. But the pistilline flowers alone have spiral peduncles: the stamineous ones are seated on short stalks near the roots of the plants, and at four or six feet below the surface of the water. When, however, the pollen is ripe and fit to fertilize the ovules, the stamineous flowers detach themselves, and rising by their lightness to the surface of the water, their petals, by which the stamens are protected, open by the influence of the sun, and the stamineous flowers mingling with the pistilline ones already elevated on their spiral peduncles, the pollen is easily shed from the one upon the other, and the seeds are fertilized. It is added, that when the seeds are ripened the spiral peduncle again contracts, as it does in *Cyclamen*, and carrying down the capsule buries the seeds in the mud.

(1307.) None of the *Hydrocharinæ* are noxious plants, and very few have been applied, or appear to be applicable, to any useful purposes. The Hydrilla (the *Vallisneria alternifolia* of Roxburgh,) is the Junji of Hindoostan, and is one of the plants employed to supply water mechanically to sugar during the process of refining. The fruit of Enhalus is edible, and it affords a fibre which, according to Agardh, is capable of being woven into various fabrics.

(1308.) The *Vallisneriaceæ* form the last type in the section *Hydrocharinæ*, and the *Hydrocharinæ* the last section in the order Musales, with which order the class Palmares ends. It therefore

only now remains to give the usual tabular conspectus of the various types and sections included in the several orders, with references to their respective definitions.

- PALMARES (1075)
  - MUSALES (1206)
    - HYDROCHARINÆ (1297)
      - *Vallisneriaceæ* (1303)
      - *Hydrocharaceæ* (1302)
      - *Stratiotaceæ* (1301)
    - ORCHIDINÆ (1273)
      - *Orchidaceæ* (1281)
      - *Cypripediaceæ* (1282)
      - *Apostasiaceæ* (1283)
    - SCITAMINÆ (1254)
      - *Marantaceæ* (1270)
      - *Zingiberaceæ* (1264)
      - *Musaceæ* (1263)
    - NARCISSINÆ (1219)
      - *Iridaceæ* (1153)
        - *Ferraridæ* (1251)
        - *Crocidæ* (1251)
      - *Burmanniaceæ* (1241)
        - *Burmannidæ* (1244)
        - *Hæmadoridæ* (1243)
      - *Amaryllaceæ* (1238)
        - *Amaryllidæ* (1237)
        - *Hypoxidæ* (1237)
      - *Bromeliaceæ* (1222)
        - *Bromelidæ* (1227)
        - *Tillandsidæ* (1224)
    - TACCINÆ (1208)
      - *Dioscoraceæ* (1114)
      - *Taccaceæ* (1211)
  - LILIALES (1146)
    - LILIACINÆ (1166)
      - *Smilaceæ* (1203, 1172)
        - *Smilacidæ* (1203)
        - *Parisidæ*
      - *Colchicaceæ* (1200, 1171)
      - *Liliaceæ* (1194, 1170)
      - *Asphodelaceæ* (1176, 1169)
        - *Aloïdæ* (1188)
        - *Scillidæ* (1181)
        - *Gilliesidæ* (1179)
      - *Pontederiaceæ* (1168)
    - ALISMINÆ (1157)
      - *Butomaceæ* (1162)
      - *Alismaceæ* (1158)
    - EPHEMERINÆ (1149)
      - *Ephemeraceæ* (1154)
      - *Xyridaceæ* (1153)
      - *Aphyllanthaceæ* (1151)
  - JUNCALES (1100)
    - JUNCINÆ (1136)
      - *Juncaceæ* (1139)
      - *Restiaceæ* (1138)
        - *Eriocaulidæ*
        - *Restionidæ*
        - *Centrolepidæ*
    - NAYADINÆ (1128)
      - *Juncaginaceæ* (1133)
      - *Podostemaceæ* (1131)
      - *Nayadaceæ* (1128)
    - ACORINÆ (1116)
      - *Lemnaceæ* (1125)
      - *Callaceæ* (1121)
      - *Orontiaceæ* (1117)
    - TYPHINÆ (1103)
      - *Typhaceæ* (1109)
      - *Pandanaceæ* (1104)
        - *Pandanidæ* (1104)
        - *Cyclanthidæ*
  - PALMALES (1085)
    - PHŒNICINÆ
      - *Arecaceæ* (1097)
        - *Cocoïdæ* (1097)
        - *Arecidæ*
      - *Phœnicaceæ* (1088)
        - *Sabalidæ* (1094)
        - *Coryphidæ*
        - *Borassidæ* (1093)
        - *Calamidæ* (1089).

GEOGRAPHICAL DISTRIBUTION OF THE PALMARES.

(1309.) This, the only other class which can vie with the preceding in importance, as affording food for animals and man, is, like it, most extensively distributed over the surface of the earth; some representatives being found in every latitude, from the equator nearly to the poles. But, though some of the numerous genera and species are thus found to prevail in nearly every region, they are not all cosmopolites; a few sections, genera, and species, are present almost everywhere, but the range of the majority is confined within certain limits, of greater or less extent in different instances, and some are absolutely local. This will be evident from the following conspective summary of the topographical distribution of the various types and sections included in the four orders of this class, which, as it will afford materials for the more general survey, may advantageously precede the account of the vegetable statistics of the zones and regions.

(1310.) The Palms, which, from their size and peculiar port, form such a characteristic feature in the vegetation of warm countries, are chiefly intertropical plants; very few are even found in the southern parts of the temperate zones, and none in their northern regions. From 35° to 38° is their utmost range from the equator in the southern hemisphere, and from 40° to 43° or 44° in the northern. In the New World, one species, *Chamærops palmetto,* alone reaches so far north as 36°; but, in the Old World, *Chamærops humilis,* the only European palm, is found near Nice, in latitude 43°-44°; and the contrary extreme on the other side of the equator is in New Zealand, in latitude 38° south. But, as Martius observes, even this confined geographical range is not fully enjoyed by all. Most of the palms are so exclusively local, that Humboldt and Bonpland lost some of the old, and discovered new species, in almost every fifty miles of their journies through the vast forest regions of tropical America. The cocoa is one of the most widely spread of the palms: *Borassus flabelliformis* and *Acrocomia sclerocarpa* have also a comparatively extensive range. The equatorial regions of America appear to be peculiarly favourable to the growth and development of palms, as there they are found not only of the greatest size, but in by far the greatest numbers; for, of less than two hundred species now known, considerably more than half, indeed nearly two thirds, are South American. Asia is less prolific of these plants than America, Africa still less so than Asia, and Europe can scarcely boast the possession of a single species; the numbers being, for Europe, 1; Africa, 14; Southern Asia, 42 to 50; South America, 119 and upwards. In New Holland only three or four palms have been discovered; on the western coasts, even within the tropics, none have been found; and from South Africa they are wholly absent. The most important African species are the date, the doum, and the oil palms; in Congo and Guinea about six or eight species have been found, and as many are known in the Isles of France and Bourbon.

(1311.) The Juncales are more widely distributed than the palms: the arborescent ones being chiefly found within the tropics, or in warm latitudes; the herbaceous species in the cold or temperate regions. Thus while the *Typhaceæ* abound in the swamps and marshes of the northern and temperate zones, and are rare within the tropics, the *Pandanaceæ* are almost exclusively found in tropical islands, especially in those of the Indian Archipelago; and the large sandy plains in the Isle of France are covered with the curiously rooting *Screwpine.* The subtype *Pandanidæ* belongs to the Old World, the *Cyclanthidæ* to the New; but

the *Pandanaceæ*, on the whole, are comparatively scarce in the Western hemisphere.

(1312.) Again, of the ACORINÆ, although the *Lemnaceæ* occur both in the equatorial and towards the polar regions, the Acorinæ, on the whole, are much the most abundant within the tropics, and gradually become fewer in the temperate zones; one only of the *Callaceæ*, viz. *Calla palustris*, reaches latitude 64° in Lapland; and although in warm countries they assume an arborescent port, in colder climates they are lowly herbaceous plants: their growth is most exuberant in the swamps of Hindostan.

(1313.) The NAYADINÆ, as is the case with most water-plants, have a very extensive range. The JUNCAGINACEÆ and NAYADACEÆ are present by some of their representatives in every latitude even from Iceland to the line; they are, however, the most common in the cold and temperate regions, while the *Podostemaceæ* are most frequent in the torrid zone.

(1314.) Of the Juncinæ the two types are reversed in their distribution; the RESTIACEÆ being all, except *Eriocaulon*, extra-European and chiefly natives of warm countries, such as South America, Southern Africa, and New Holland, while the *Juncaceæ*, or true rushes, are rare in the equinoctial regions, but common in cold and damp situations in the temperate and frigid zones. Their proportion to other flowering plants has been calculated by Humboldt to be $\frac{1}{25}$ in the frigid zone; $\frac{1}{90}$ in the temperate; and only $\frac{1}{400}$ within the tropics.

(1315.) The EPHEMERINÆ are chiefly natives of warm countries; the Xyridaceæ being mostly tropical plants, and the *Ephemeraceæ* denizens of the East and West Indies, and Africa. A few occur in North America, as do some of the Xyridaceæ, but they are absent from the northern parts of Asia and Europe.

(1316.) The ALISMINÆ enjoy the usual privilege of aquatics, and occur in the equatorial as well as in the temperate regions, but they are most common in the colder latitudes of either hemisphere.

(1317.) The LILIACINÆ exhibit a similar extensive range. A few, as the PONTEDERIACEÆ, being found in the East Indies and in Tropical Africa, and North and South America, but the majority, as the ASPHODELACEÆ and LILIACEÆ, in the temperate regions; the Smilaceæ and Colchicaceæ are very widely spread over all parts of the world, but their maximum, especially that of the latter, is towards the north.

(1318.) The TACCACEÆ, and Dioscoraceæ, are almost exclusively tropical plants, natives of the eastern and western hemispheres. Tamus alone occurs in Europe.

(1319.) The BROMELIACEÆ, although now naturalized in the Old World both in Africa and the East Indies, have migrated from the West Indies and the American Continent, to which they were originally peculiar, and where they still abound.

(1320.) The AMARYLLACEÆ are comparatively rare in the northern parts of the temperate zone; in the southern parts they increase in number and beauty; but it is in the East and West Indies, at the Cape of Good Hope, and especially in Tropical America, as in Brazil, that they reach their highest degree of relative proportion and the climax of their splendour.

(1321.) The BURMANNIACEÆ are also mostly tropical plants, the *Hæmodoridæ* abounding at the Cape of Good Hope and in Brazil; the *Burmannidæ* both in Asia and Africa, as well as America between the tropics.

(1322.) The IRIDACEÆ are more northern in their distribution than the pre-

ceding groups; in the equatorial regions comparatively few are known, their maximum being in the temperate parts of America and Europe.

(1323.) The SCITAMINÆ, on the contrary, are almost exclusively tropical plants, the MUSACEÆ flourishing only in hot countries, and hardly any of them, or of the ZINGIBERACEÆ or MARANTACEÆ, being found without the tropics.

(1324.) The ORCHIDINÆ are spread over all the moist and temperate regions of the globe. Extreme cold and dryness are however inimical to them, none being found within the frigid zone; and they are absent or nearly so from the sandy districts of Africa; but at the Cape of Good Hope they abound. In the East and West Indies, and other countries lying within the tropics, the epiphytic *Orchidaceæ* alone prevail; one only being known to reach so far north as South Carolina.

(1325.) The HYDROCHARINÆ are found in various parts of Europe, Asia, Australia, Africa, and America; the *Vallisneriaceæ* being rather the more southern, and the *Hydrocharaceæ* the more northern group. The Stratiotaceæ are about equal both within and without the tropics; their watery habitats equalizing the temperature, favors their wider geographical range.

(1326.) Thus it will appear that, although nearly universal in their distribution, the *Palmares,* like the previous classes, differ very greatly as to the groups which prevail in different regions, some of which are hence characteristic of the vegetation of certain latitudes, and others even of certain districts or localities, while very few enjoy an unfettered range.

Hence, statistically considered, the several geographical or rather botanical zones and regions possess each a flora peculiarly characteristic and more or less exclusively its own; a flora in which the presence or absence of certain groups of the Palmares, and their relative proportions to other plants, forms one of the most striking features.

(1327.) In the equinoctial zones extending to about 30° on either side of the equator, the arborescent Palmares, and especially the palms, if not exclusively found, occur in so much greater relative proportion, that they give that aspect to the landscape which has long been designated tropical. In these zones alone are found forests of columnar branchless trees, with all their leaves collected into terminal crowns, borne high into the air, and as vast as they are lofty. In these zones alone are seen herbs, or half herbaceous half arborescent plants, such as the Musaceæ, developing immediately from the soil leaves ten or fifteen feet in height by two feet in width, and attempting to form by their embracing leaf-stalks a spurious stem to vie with the pillar-like trunks of palms. Here almost alone are found the Ginger tribes, and those of the Cannæ and their allies. The *Pandanaceæ, Dioscoraceæ,* and *Taccaceæ,* are also peculiar to this zone, one only, viz. Tamus, being extratropical: to these must be added the epiphytic *Orchidaceæ,* the splendid *Agaves,* with the other *Bromeliaceæ;* and the *Burmannidæ,* the *Hæmodoridæ,* and the *Ephemeraceæ;* the *Restiaceæ* here supersede the *Rushes,* and the bulk of the *Amaryllaceæ* are likewise found: for, although these last named extend with the true *Liliacinæ* into the temperate regions, their predominance both in magnificence and number is in the equinoctial zones. To the above must be also added, in the statistical account of the vegetation of these zones, the Xyridaceæ, and the aquatic *Pontederiaceæ* and *Pistia* of the *Lemnaceæ.*

(1328.) In the northern regions the rushes (*Juncaceæ*), which are almost

absent from the intertropical zones, are the predominant or prevailing group of the Palmares; next to them are found some of the *Orchidaceæ*, the *Typhaceæ*, *Alismaceæ*, and *Colchicaceæ*, with the aquatic *Nayadaceæ*, none of which latter are however so decidedly northern groups as the *Rushes*, or as the *Mosses*, *Fungi*, and *Lichens* of the *Mycaffines*; for the *Colchicaceæ*, *Alismaceæ*, and *Nayadaceæ*, (although some of the latter, as the potamogetons, fill the frozen ponds and ditches of Lapland,) are also frequent in the temperate zones; and a few of them, as is common with aquatic plants, extend even into the equatorial regions.

(1329.) In the temperate latitudes the vegetation blends in part the characters of the polar and equatorial regions; the northern districts partaking mostly of the former's, its southern of the latter's flora.

Thus the *Juncaceæ*, *Typhaceæ*, *Nayadaceæ*, and *Colchicaceæ*, are all present, but gradually decrease in their prevalence as the parallels are lower; while the *Ephemeraceæ*, *Amaryllaceæ*, *Orontiaceæ*, and *Callaceæ*, as progressively lessen in the higher latitudes. The *Iridaceæ*, *Asphodelaceæ*, and the true *Liliaceæ*, are the predominating Palmares of the temperate zones; for, although extending on either side, they are by far the most prevalent in the extratropical and extra-polar regions.

(1330.) Thus it will be found that the relative proportion of the Palmares is greatest in the tropical, and least in the polar zones; that this relative predominance is still more marked in the petaloid and arborescent ones than in those which are herbaceous; and that it is the northern range of the Juncaceæ which lessens numerically the common or general proportion.

(1331.) This circumstance, taken in conjunction with the predominance of the grasses and sedges in the temperate and northern regions, explains the apparent paradox that the monocotyledons are relatively less in number to other flowering plants within the tropics, than either in the temperate or polar regions, notwithstanding tropical vegetation is said to be marked and distinctively characterized by them.

The vegetation of the tropics is not however, in fact, more characteristically distinguished by the presence of monocotyledons than that of the temperate regions; for the compact green turf which clothes the sides of our hills and extends over our plains, is a feature not less peculiar to the temperate zones than the Bananas and Palm forests are to the tropics; the difference is marked not so much by the absolute prevalence of monocotyledonous plants, as by their relative distribution, the arborescent and more splendid flowering tribes prevailing in the equatorial zones, the less showy and herbaceous ones in extratropical regions.

(1332.) Such being the case, it is found that these two classes, the Gramina and Palmares, which afford their chief supplies of food to man, afford it in different proportions in different latitudes. In the polar and temperate zones the cereal grasses yield almost exclusively the main supplies of food, while in the southern temperate, and equatorial regions, although still in many places most important, supplies are no longer exclusively, often not principally, derived from them; and in the majority of the South Sea islands corn is unknown, the Palmares, which in other parts more or less shared with the grasses the right of purveying human food, superseding entirely their use.

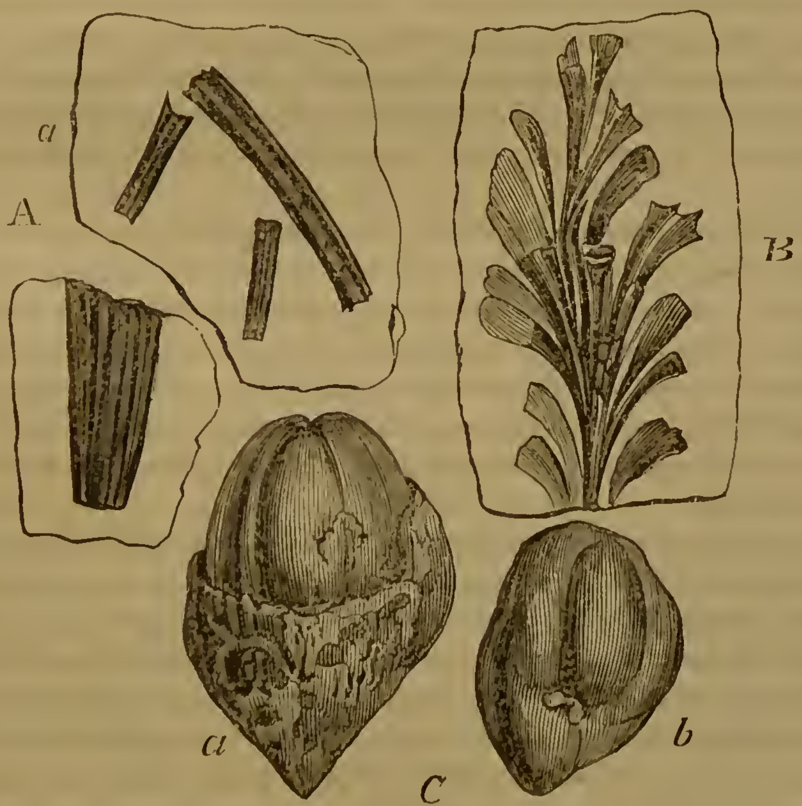
(1333.) Altitude, it is well known, affects the vegetation in as great a degree as latitude, so that palms and bananas may be the food of the inhabitants of the

plains, and corn that of those who dwell above the clouds, just as they are of the nations of the tropical and extra-tropical zones; for corn fields, which within the arctic circle are on the lowest lands, in the temperate regions rise on the sides of hills to the height of one, two, three, and even four or five thousand feet: and in the torrid zone they are elevated to eight or ten thousand feet above the level of the sea. Potatoes are cultivated at an elevation of above 12,000 feet, and some pasture grasses will grow even at the enormous height of between thirteen and fourteen thousand feet; while the corn fields, the palm groves, and the banana plantations, are all below them; and a traveller, descending Chimborazo from the regions of perpetual snow, would pass through the successive gradations of climate, and observe its progressive influence on vegetation to be analogous to that which would be witnessed in a journey towards the equator from the pole.

(1334.) Many places, however, have their climate much affected by other circumstances besides altitude and their distance from the equator. Thus islands have their atmosphere moist, their temperature moderated, and extremes are lessened both of heat and cold; and some places, such as Japan, would almost seem to have climates peculiar to themselves, as evinced by the effects on their characteristic vegetations.

GEOLOGICAL DISTRIBUTION OF THE PALMARES.

(1335.) The fossil remains already discovered in numerous strata, ranging from the coal series to the uppermost beds of the tertiary formation, afford sufficient proofs of the existence of the PALMARES in those geological epochs during



A. *Cyperites bicarinata.* (*a*) Natural size. (*b*) Portion magnified, to shew the secondary veins.

B. *Noeggerathia flabellata*, reduced.

C. Fossil cocoa-nuts. (*a*) One with the pericarp in part destroyed. (*b*) Another entire.

which the successive strata were formed. Concerning three orders, viz. the MUSALES, LILIALES, and PALMALES, the evidence is full and complete; concerning the fourth, the JUNCALES, although satisfactory, it is less abundant and decisive.

(1336.) The rushes (Juncales) being the plants most nearly allied to the grasses, in structure, habits, and functions, might naturally be expected to obey the same law in their geological relations as it has been already shewn that they do in their geographical distribution; and this law is most closely followed by those groups which are the most grasslike, such as the *Juncaceæ* and *Restiaceæ;* and the least closely by those which are transitional to other sections, such as the *Pandanaceæ* and *Nayadinæ.*

(1337.) It has already been observed, in the "Outlines of Graminologia," that satisfactory evidence has not hitherto been offered of the existence of any grasses in a fossil state. The fossil named *Cyperites bicarinata* [1335, A, *a*, *b*,] there referred to as bearing the greatest resemblance of any known fossil to the Gramina, is acknowledged on all hands to be of very questionable affinity, and the fossil genera, *Endogenites, Culmites,* and *Poacites,* are at least as likely to be the remains or the impressions of *Juncinæ,* or of linear-leaved *Liliales,* as of grasses or sedges.

(1338.) A similar uncertainty prevails as to the former existence of the true rushes (Juncaceæ): negative evidence is all that can be adduced, no fossil remains of rushes having hitherto been found; and, their habits and functions being known, it is not improbable, reasoning from analogy, that in the earlier epochs they, as well as grasses, did not exist. The rushes are now the plants especially of cold and temperate latitudes; it is therefore unlikely that they should abound at a time when the present temperature of the tropics extended almost to the poles.

Echinostachys, the only fossil that bears any strong resemblance to the Juncinæ, is compared by Brongniart, not to the Juncaceæ, but to the southern group, the Restiaceæ.

(1339.) Of the *Pandanaceæ,* which now are tropical plants, some faint indications have been found; for the fossil stems of the coal formation, which have been named *Sternbergiæ,* are suspected by Brongniart to have belonged to a Pandanus or some plant of the same type, although, as he observes, they may be those of other arborescent monocotyledons, such as *Yucca, Aletris,* &c. A fossil fruit found in the tertiary strata has also a greater resemblance to the fruit of this than to that of any other natural group, and it has been therefore named *Pandanocarpum.*

(1340.) Eight or nine representatives of the *Nayadaceæ* have been found in a fossil state, the majority of which, seven species, bear so close a resemblance to the existing genus Zostera, that they have been called *Zosterites:* one is so similar to the modern Caulinia that it has been named *Caulinites;* and the other, concerning which there is a doubt whether it should be associated with the Nayadaceæ or Alisminæ, is considered by Brongniart so like the linear-leaved potamogetons, that he has converted the original name, *Phyllites,* into *Potamophyllites.*

(1341.) Of the *Acorinæ* no traces have hitherto been found in a fossil state.

(1342.) Excepting the doubtful Phyllites [§ 1340], the *Alisminæ* would appear to have been without representatives in the earlier ages of the world.

(1343.) *Palæoxyris,* a fossil discovered in the new red sandstone, has been so named from its resemblance to the modern genus Xyris; its relation, however, is not unquestionable. Should its presumed affinity be correct, it will be the only representative of the Ephemerinæ at present known.

(1344.) Of the former prevalence of the *Liliacinæ,* especially of the types Asphodelaceæ and Smilaceæ, abundant testimony is at command. Vestiges of the latter occur in the slate, the green and variegated sandstone, and the tertiary strata. The Bucklandia is a fossil stem, covered with fibres and the bases of non-amplexicaul leaves: perhaps it belonged to a forerunner of our Dracænæ or Xanthorrhœæ, as it is evident that the leaves were not amplexicaul, and the petioles distinct at the base. And Clathraria, one species of which has been found in the green sand-stone, is another stem that, notwithstanding the union of the bases of the leafstalks, is apparently allied to Xanthorrhœa. The two fossil species of Convallarites claim kindred with our present Convallariæ; but the immediate affinities of Antholithes is not so clear.

The only representative of the Smilaceæ yet discovered is the *Smilacites hastata* of the lower fresh-water formation.

(1345.) The indications of the Musales are very few, and those confined to the types of a single section, viz. the Scitaminæ; of the others no traces have hitherto been found. The Cannophyllites, referred to the Marantaceæ, is a fossil of the coal strata, but found in a bed of more recent date than the old and principal formation. Two species of fruit have also been discovered in the coal-measures, which are believed to have belonged to some pristine Musaceous plants, and hence have been called *Musocarpum prismaticum* and *M. difforme.* Amomocarpum, found in the tertiary series, is supposed to be the fruit of a plant related to the Zingiberaceæ; but Trigonocarpum, of which five species occur in the coal beds, although bearing the impress of the Palmares, does not afford means to trace its affinities further.

(1346.) The Palms alone now remain to be considered, and of them the stems, leaves, and fruit, have been discovered in a fossil state. The leaves are found chiefly in the coal formation, the stem and some leaves in the London and plastic clay, a few leaves in the lower fresh-water formation, and the rest, with the fruit, in various parts of the tertiary series.

(1347.) The successive geological epochs in which the several strata forming the crust of the earth were deposited, may be considered in some measure as equivalent to the various parallels of latitude that mark the zones and climates of the present surface; and hence, in the geological survey, besides the local distribution of the fossil remains analogous to the topography of existing orders, it is essential that the fossil floras of the several epochs should be considered, which view, in the fossil summary, is analogous to the vegetable statistics of the several zones.

(1348.) From the transition series, in which both marine Algæ and various ferns are found, the Palmares would seem to be altogether absent.

(1349.) Even in the coal measures, where the fossil remains of ferns are most abundant, only eighteen species (according to Brongniart's calculation,) belonging to this class have been discovered. Of these, three are the relics of true palms, one of the order Musales, and fourteen, the immediate affinities of which, as already shewn, are somewhat questionable, although no doubt exists that they are

vestiges of plants allied to the Palmares, and in all probability belonging to the groups to which they have been previously referred.

(1350.) In the variegated sandstones, although but five species are catalogued, remains of the flowering Endogenæ, says Brongniart, are more numerous, better characterized, and seem to shew, by the varieties of their forms, that they constituted more than a fourth part of the species of that epoch, notwithstanding they do not appear to have formed so much as a fourteenth part of the flora of the coal era.

(1351.) In the shelly limestones not any traces of these plants have been hitherto discovered. Indeed, the whole of the upper strata of the secondary series afford but few fossil remains of the Palmares: only three are named by Brongniart, two of which belong to the Jura limestone, and one to the Stonesfield slate.

(1352.) In the tertiary beds the Palmares again predominate; and, although not amounting to more than a fourth part of the Rosares, or angiospermous Exogenæ, they are in greater relative proportion in this epoch than any other class, save the one referred to, and hold to it the same proportion that the existing species of each do to each other in the present day.

(1353.) Exactly as it occurs with the other classes, so it is found with the Palmares, that the fossil remains in the upper tertiary beds bear the closest resemblance on the whole to the present existing race of plants: for example, several species of Cocos and of Flabellaria, and of plants so like Phœnix, Zostera, and Caulinia, are found, that they have been absolutely named *Phœnicites, Zosterites,* and *Caulinites.* Pandanocarpum and Amomocarpum are also the fossils of this epoch.

(1354.) In the fossil *Palmares* of the upper secondary strata the similitude is less close, but the resemblance, though fainter, when traceable, is still chiefly to the aquatic Palmares, or to those especially of our warmest latitudes. And in the coal formation this tendency is still more notorious, where the *Musocarpa* and *Sternbergiæ* alone are found, along with *Noeggerathia, Zeugophyllites,* and *Cannophyllites,* and the *Trigonocarpa,* the affinities of which with existing plants are extremely doubtful.

(1355.) It will hence appear, as far as conclusions may be drawn from the evidence attainable in the present day, which it is confessed as yet is meagre, that the Palmares, though not the earliest, were among the earliest plants which clothed the surface of the globe; and, although bearing but a small relative proportion to the ferns and other vegetables which purified the air in the coal epoch, still that they can be traced back to that age in which there is evidence that some representatives of the noblest tribes, as the Palms and the Bananas, flourished.

It is however subsequent to that period, when, as already shewn, it is probable that the grand operation of consolidating the atmospheric charcoal was principally performed, that palms and their allies attained their greatest relative proportion, in the coal era being not more than one-fourteenth, while in the upper secondary strata they formed one-fifth, and in the tertiary series one-fourth of the then existing floras.

(1356.) These geological positions are in strict accordance with their present geographical distribution, and with that scheme which similar geographical and geological researches in the preceding classes have indicated, and which, analogous

investigations into the physical conditions and relations of the succeeding ones will yet more fully confirm. Preparations are here made for the sustenance of amphibions and terrestrial animals, and especially of such as require immense supplies of vegetable food, and rather browse than graze. From the orders to which they are allied none of the fossil Palmares would appear to have been poisonous plants, none of them even suspected to have been deleterious; but all of them wholesome, and most of them very nutritious. It is affirmed by practical men that the *Musæ* of our tropics yield at least twenty times as much human food from a given space as corn or any of our cereal grasses; and if their immense leaves be taken into the calculation as fit provender for brute animals, as their fruit only is used by man, the amount would greatly be increased.

(1357.) Grasses however, or at least grass-leaved Palmares, may have been contemporaneous with the other orders, some of the fossils called Cyperites and Poacites being found in the coal measures, and others, as the *Culmites* and *Endogenites,* in the tertiary series; but it is evident, both from the direct proofs derived from the fossil witnesses which science has summoned to her council, as well as from the indirect testimony afforded by the well-known uses, habits, and functions of such plants, that, if they even existed, grasses and grass-leaved vegetables formed but a very small relative proportion of any of the ancient floras of the world.

(1358.) The Ferns, the Grasses, and the Palms, with their respective allies, associated to form the classes severally named Filices, Gramina, and Palmares, although differing greatly in many particulars, such as the want of flowers, the want of perianth, and the suppression of glumes, with the development of calyx and corolla, possess various characters in common by which they are strongly contrasted with other groups of classes, and are associated to form a region or province. Collectively considered, this triple alliance has been variously named, according to the views of various systematic writers; and as the Ferns, notwithstanding their tubivascular structure, are by some botanists of note pertinaciously denominated cellular plants, they are by such persons excluded from this region, and combined with the Mosses, Flags, and Fungi, with which their affinities are much less close. Habit, use, external form, and internal structure, all proclaim the first affinity of the Ferns to be with the arborescent grasses and the Palms; and even their secondary connexion tends rather to the Pines and Zamias, than to any class or order of the Mycaffines. Their destitution of flowers is in fact the only striking feature of resemblance between the *Filices* and the cellular flowerless plants: while the unstratified tubivascular stems of all, the jointed, fistulose stipitellæ, siliceous cuticle, and coniferous fructification of some; and the solid fariniferous stems of others, with circinnate vernation, or congested

linear foliage, shew very strong and numerous points of similitude between their several orders, and those of the *Palmares*, *Gramina*, and *Pinares*.

(1359.) Hence it will be evident that the various collective names which have been proposed are not all strictly synonyms; some being devised for the purpose of including, and others of excluding the *Ferns*. Thus *Monocotyledones*, or *Plantæ unilobatæ*, having reference to the embryo of the seed-bearing groups alone, are terms applicable to the Gramina and Palmares only; for the cotyledon in these plants is solitary, or, if two occur, they are alternate: and from such seeds, especially when replete with albumen, having been called grains, the plants which have them have been termed *Graniferæ*.

(1360.) The mode of germination and the intimate structure of the seed, have afforded other characteristics, and suggested another name; for in these plants the whole surface of the embryo is undivided, the radicle being inclosed in a case, the *coleorhize*, [§ 1270, *h*,] through which it bursts; and hence the term *endorhizæ*, which is far better and more correct than monocotyledones, even when applied to those plants alone which that term is commonly employed to designate, has been proposed by the celebrated Richard.

(1361.) Again, the disposition of the vessels in the stems, and their distribution in the leaves, forming veins, are peculiar. The structure is not homogeneous, as in the *Mycaffines*, but heterogeneous, being formed of tubes and cells; yet these tubes and cells are blended and mixed together in one mass, and there is no distinction of parts for the ascent or descent of the sap; in short, no *old* or *heart-wood*, *new* or *sap-wood*, *bark*, *pith*, &c. disposed in strata, (as will be found in the following region;) hence they have been called unstratified plants, for the cellular enchyma of the Mycaffines and the *vestigia foliorum* of the palms, do not deserve the name of strata any more than the hardened external rings found in their stems, in each of which, if at all distinguishable, those very parts are confounded together, viz. bark and wood, that in stratified plants are disposed in layers.

(1362.) The foliage in these unstratified plants appears also to be rather an expansion of the substance of the stipe than an exsertion of a distinct organ, as in the articulated leaves of the *Cresses*, and their allies (*Crescaffines*.) Hence the veins run

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directly, in general, from the base to the apex or the margin of the leaves, without any anastomoses or reticulations. A single terminal bud is usually alone developed; and therefore, when a stem is formed, it is commonly unbranched and nearly cylindrical.

(1363.) But these three classes are characteristically associated not only by the unstratified structure of their simple, columnar, branchless stems; but it is observable that the oldest parts of those which are perennial are situated externally, and the newer fibres, by which the vital actions of the plant are performed, are deposited within the older ones, often quite in the middle of the stem, so that the centre is the softest and the most energetically active; the outer parts the oldest and the hardest, and scarcely, if at all, alive. This curious mode of depositing the annual growths which is prevalent in the *Palms*, the *Grasses*, and the *Ferns*, is diametrically opposed to that which prevails in the succeeding classes, in which, as will hereafter be shewn, the annual deposits take place externally. Hence these three classes of inside growers have been termed by De Candolle ENDOGENÆ, as the succeeding classes, which are outside growers, have been named, by the same distinguished botanist, EXOGENÆ.

(1364.) Although this is the general law of their increase, numerous aberrations prevail. Thus, in Xanthorrhæa, one of the Liliacinæ, and decidedly an endogenous plant, the walls of the stem are traversed by fibres in a radiating form proceeding from the circumference towards the centre. In their disposition these rays somewhat resemble a texture called the medullary rays in the Exogenæ; but the structures of the two are very different; in Xanthorrhæa, the rays consist of fibres or fascicles of tubes, going to nourish and support the leaves which crowd thickly the outside of the stem; in Cycas and the rest of the Pinares, and indeed, in all the Crescaffines, the rays are formed by plates of cellular substance only, running in a horizontal direction, and the individual cells of which lie partly over each other, constituting that form of *Enchyma* or pulp, which has received the name of muriform tissue.

(1365.) *Dracæna*, another liliacinous plant, the structure of whose unstratified stem would decidedly place it amongst the Endogenæ, even if no reference were made to its foliage and unilobate or monocotyledonous seeds, is still anything but strictly endogenous, *i. e.* inside growing. Its stem *is branched*, is *not* cylindrical, and increases in girth as it increases in age. For, according

to the description of Du Petit Thouars, each branch is connected with the stem by fascicles of fibres, which, instead of being all confined to the centre of a cylindrical shaft, force themselves between the dense woody axis or column which at first is formed, and the exterior mass of pulp or enchyma, and produce an external layer. But this layer, as to its contents, is still unstratified, and though situated outside of the previous deposits of vessels, so that the trunk increases in diameter, and much of the newer increments are external, still it differs much in its relative position from any annual stratum in the Exogenæ, and thus the Dracæna, if not a strictly endogenous or inside growing, but rather an exogenous or outside growing plant, is nevertheless virtually the same with the former, and differs from the latter in every essential point.

(1366.) *Pandanus* among the *Typhinæ* is another celebrated exception, both in its growth as an Endogenous plant, and its evasion of the limit set by their structure to the duration of its allies. The *pith-bearing rushes*, the *branching Asphodelaceæ*, and the *arborescent Gramina*, with their tapering non-columnar stems, as well as the *Smilaceæ*, *Dioscoraceæ*, &c. with the reticulate or subreticulate venation of their leaves, are all further examples of deviation in various ways from the strict and leading characters of the group. But these instances, and many others which might be adduced, as partially abnormal in the sections to which they belong, are possessed of a double interest. In the first place they are important when considered simply as gradations towards the structure confirmed in the third great region, the true *Exogenæ* or Crescaffines, which approach them by the *Cycadaceæ* of the *Pinares*, immediately to be described; and in the second, as affording ample proof that no one character is so universally present in this, and so constantly absent from other groups, as to form alone a sufficient and satisfactory diagnosis. The differential signs of natural associations are necessarily collective, and relative differences often depend on relatively different combinations only; therefore one or other, or even all the elements, may in turn be absent, and yet the concurrence of several, or of the majority, be rightly deemed conclusive.

(1367.) *Endogenæ*, it will therefore be perceived, is not a wholly unobjectionable term, although far preferable to *Endorhizæ*, and *Monocotyledones*, which are utterly inapplicable to this region when it includes the *Ferns;* for, notwithstanding in

them a preparation for flowering and rudiments of cotyledons exist, these parts can only be considered in them as the shadows which coming events have cast before; and hence a name derived from the inevitable tendency of the endogenous structure, viz. the *term* or *limit* which it sets to the existence of the plant, is here proposed in its stead. This tendency has already been explained [§ 77—79], and the adoption of the compound word TERMAFFINES in preference to *Termes*, has also been defended. It therefore need only be added, that this more comprehensive name does not imply any error; it simply states that the plants included possess a structure similar to those which inevitably perish by the consolidation of their cylindrical stems, whether they may by some abnormal course be enabled, as in Pandanus and Dracæna, to escape the common fate, or whether, as in many annual or herbaceous groups, they never reach the length of life, to feel the influence of the relentless band which their characteristic structure would, if they lived long enough, year by year confirm.

(1368.) The progressive gradations of structure by which the types, sections, and orders included in the several classes of this region, are distinguished from each other, and associated to form larger and larger groups, are, as already explained, relative rather than absolute distinctions; hence, although not designed for an index, a summary conspectus similar to that which concluded the history of the *Mycaffines* may be useful, as contrasting more strongly than any other means could do the various stages of development.

(1369.) Of necessity the chief differential characters alone are given in the following table, but as it is intended rather to illustrate the natural series of evolutions which proceed almost uninterruptedly from one stage to another through the whole vegetable kingdom, than to subserve the purpose of an artificial clue, constant references should be made to the preceding pages, for more full details whenever the connexions are forgotten.

TERMAFFINES. Tubivascular unstratified endogenous plants.	PALMARES. Non-glumose flowering endogenæ.	*Musales* *Liliales* *Juncales* *Palmales*
	GRAMINA. Glumose flowering endogenæ.	*Graminales* *Cyperales*
	FILICES. Flowerless endogenæ.	*Equisetales* *Pteridales* *Selaginales.*

Classes.	Orders.	Sections.	Types.	
PALMARES.	MUSALES. Inferior germen.	HYDROCHARINÆ. Tripetalous, exalbuminous.	*Vallisneriaceæ.*	Stam. fl. synpetalous, pistilline fl. apopet. capsular.
			Hydrocharaceæ.	Fl. upopetalous, fruit capsular, leaves with transverse veins.
			Stratiotaceæ.	Fl. spathaceous, apopet. frt. baccate, lvs. sheathing.
		ORCHIDINÆ. Gynandrous, (albuminous?)	*Orchidaceæ.*	Monandrous flowers, one-celled ovary.
			Cypripediaceæ.	Diandrous fl., one-celled ovary.
			Apostasiaceæ.	Di-triandrous fl., three-celled ovary.
		SCITAMINÆ. Tri-hexa-petalous fl., albuminous seeds, penninerved leaves.	*Marantaceæ.*	Monandrous, stam. lateral, anther one-celled.
			Zingiberaceæ.	Monandrous, stam. median, anther two-celled.
			Musaceæ.	Pent. hexandrous spathaceous flowers.
		NARCISSINÆ. Tri-hexapetalous fl., seeds albuminous, leaves nervo-striated.	*Iridaceæ.*	Triandrous fl., extrorse anthers, equitant leaves.
			Burmanniaceæ.	Tri- hexapet. fl., perianth winged or hairy, stam. mostly six.
			Amaryllaceæ.	Hexapet. hexand. fl., ensiform non-equitant leaves.
			Bromeliaceæ.	Tripet. hexandrous fl., ovary superior or inferior.
		TACCINÆ. Hexapetalous fl., grumous roots. Petiolate leaves, albumin. seeds.	*Dioscoraceæ.*	Per. subpetaloid, fl. separate.
			Taccaceæ.	Per. petaloid, fl. united, testa striate.
	LILIALES. Perianth petaloid, germen superior, ovules marginal.	LILIACINÆ. Hexapetalous fl., albumin. seeds.	*Smilaceæ.*	Per. subpetaloid, fl. separate or united, anthers introrse, testa membranous.
			Colchicaceæ.	Fl. hexandrous, anthers extrorse, styles trifid or distinct.
			Liliaceæ.	Fl. hexand., anth. introrse, styles connate, testa soft and spongy.
			Asphodelaceæ.	————, anth. introrse, testæ black and brittle.
			Pontederiaceæ.	Stamens unequal, perianth irreg. and involute.
		ALISMINÆ. Seeds exalbuminous, embryo uncleft.	*Butomaceæ.*	Trophosperm branched.
			Alismaceæ.	Trophosperm simple.
		EPHEMERINÆ. Tripetalous flow., albumin. seeds.	*Ephemeraceæ.*	Capsule 2, 3-celled, placent. central, emb. trochlear, remote.
			Xyridaceæ.	Caps. 3-valved, 1-celled, parietal placentæ.
			Aphyllanthaceæ.	Placentæ central, emb. included, next to the hilum.
	JUNCALES. Per. none or glumaceous, germen superior.	JUNCINÆ. Glumaceous fl., alb. seeds, small emb., central placentæ.	*Juncaceæ.*	Emb. included within the albu. next to the hilum.
			Restiaceæ.	Embryo lenticular, excluded, remote.
		NAYADINÆ. Seeds exalbuminous.	*Juncaginaceæ.*	Fl. united, glumaceous or achlamydeous, seeds erect, embryo cleft.
			Podostemaceæ.	United flowers, polyspermous capsules.
			Nayadaceæ.	Fl. separated and achlamydeous, carpels 1-seeded, ovules pendulous.
		ACORINÆ. Spathaceous and albuminous.	*Lemnaceæ.*	Fruit dry, capsular, indehiscent, axis abortive.
			Callaceæ.	Fl. achlamydeous, fruit fleshy.
			Orontiaceæ.	Fl. united, perianth scaly.
		TYPHINÆ. Ovary solitary, seeds albumin., leaves entire with linear veins.	*Typhaceæ.*	Ovules pendulous, leaves unarmed, anthers clavate.
			Pandanaceæ.	Ovules ascending, leaves armed.
	PALMALES. Arborescent stems, rigid divided leaves, hexapetaloid perianth, superior germen, median ovules, and albuminous seeds.	PHŒNICINÆ.	*Arecaceæ.*	Spathes when present complete.
			Phœnicaceæ.	Spathes numerous and incomplete.
GRAMINA.	GRAMINALES. Round articulated hollow culms, split vaginæ, embryo outside the albumen.	FESTUCINÆ. Arborescent or herbaceous, infl. paniculate, tendency to abortion in upper florets.	*Bambusaceæ.*	Locustæ many-flowered, stamens six, style single.
			Oryzaceæ.	Loc. one-flowered, glumes distinct and keeled.
			Stipaceæ.	Loc. 1, 2-flowered, glumes membranaceous, inferior glumelle coriaceous.
			Agrostidaceæ.	Loc. 1, 2-flowered, glumes and glumelles submemb.
			Avenaceæ.	Loc. 2, or many-flowered, stam. 3.
			Phalaridaceæ.	Panicles spiciform, loc. 1, 2-flowered, glumes keeled.
		PANICINÆ. Inf. spicate or paniculate, glumes keel-less, tendency to abortion in lower florets.	*Saccharaceæ.*	Infl. paniculate, rarely spiciform, loc. 1, 2-flowered, articulated.
			Miliaceæ.	Infl. spiciform, loc. 1, 2-flowered, non-articulate.
		TRITICINÆ. Inf. spicate, locustæ sessile.	*Spartinaceæ.*	Spikes unilateral, loc. sessile 1, 2-fl'd., upper impft.
			Hordeaceæ.	Spikes congested, locustæ sessile, styles two.
	CYPERALES. Angular, solid, jointless culms, entire leaf-sheaths; embryo included within the albumen.	CARICINÆ. Flowers separated	*Caricaceæ.*	Flowers separated, glumes developed.
		CYPERINÆ. Flowers united.	*Scirpaceæ.*	Glumelles pilose.
			Papyraceæ.	Glumelles absent.
FILICES.	EQUISETALES. Leafless, fistulose, articulate.	EQUISETINÆ.	*Equisetaceæ.*	Leafless, fistulose, articulate, frt. in terminal spikes.
	PTERIDALES. Foliaceous or frondose. Dorsiferous.	POLYPODINÆ. Thecæ annulate.	*Polypodiaceæ.*	Indusia absent, conceptacles naked.
			Aspidiaceæ.	Indusia present, conceptacles stalked.
			Gleicheniaceæ.	Annuli zonate, concept. sessile or subsessile.
		OSMUNDINÆ. Thecæ exannul.	*Osmundaceæ.*	Conceptacles one-valved and pellucid.
			Ophioglossaceæ.	Concept. bivalved, adnate, coriaceous opaque.
	SELAGINALES. Foliose, not dorsiferous, stems solid, inarticulate.	LYCOPODINÆ. Concept. dehiscent, or inclosed within the bases of the leaves.	*Lycopodiaceæ.*	Concept. free, axillary dehiscent.
			Isoetaceæ.	Concept. inclosed within the bases of the leaves.
		MARSILINÆ. Concept. free and indehiscent.	*Marsileaceæ.*	Concept. free and uniform.
			Salviniaceæ.	Concept. free, indehiscent, of two kinds.

OUTLINES OF PINAROLOGIA.

(1370.) The PINE, the CEDAR, the CYPRESS, and the YEW, with other less familiar, but not less interesting plants, called CYCASES and ZAMIAS, are associated, to form a class which it has been proposed to denominate, from *Zamia* and *Pinus*, the ZAPINI, but for which PINARES, a word derived from the principal and normal genus, is perhaps a preferable name.

(1371.) This, the seventh class of the ascending series, is the first of the present region, which comprehends all the flowering stratified plants; plants which are strongly contrasted with those associated in the preceding one by their normal exogenous growth; an important structural peculiarity, which, from its not fixing any term to their duration, but allowing an indefinite increase, has suggested the common collective name *Cress-allies* or CRESCAFFINES.

(1372.) Two orders only are contained in the class PINARES; and from *Zamia* and *Pinus*, the respective normal genera of each, they have been named the *Zamiales* and *Pineales*.

These are two very interesting groups of plants, for a correct knowledge of which the world is chiefly indebted to Brown, Brongniart, and Richard. They were once the most perplexing, and apparently anomalous productions of the vegetable world, being never associated, but the latter placed sometimes with the ferns, and sometimes with the palms. Since, however, their true structure has been discovered, they have formed, together, one of the most natural classes existing, and become a beautiful transitional series, establishing still more strongly than heretofore the connexion between the *Pines* or *Fir-tribes* of the *Crescaffines* or *Exogenæ*, and the *Palms* and *Ferns* of the *Termaffines* or *Endogenæ*. For, notwithstanding the change in their systematic arrangements, which a knowledge of their intimate structure has entailed, still their affinity with Ferns and Palms is not slight; and it would be folly, as lately has been too common, to

neglect or deny their several points of similitude, such as the simple stems, coronal foliage, and circinnate vernation of the *Zamiales*: to say nothing of the sporidiferous fronds and terminal fructification of the ferns, which foreshadow the cones, with the rudimentary stamina, and pistilla and naked seeds of the whole of the PINARES.

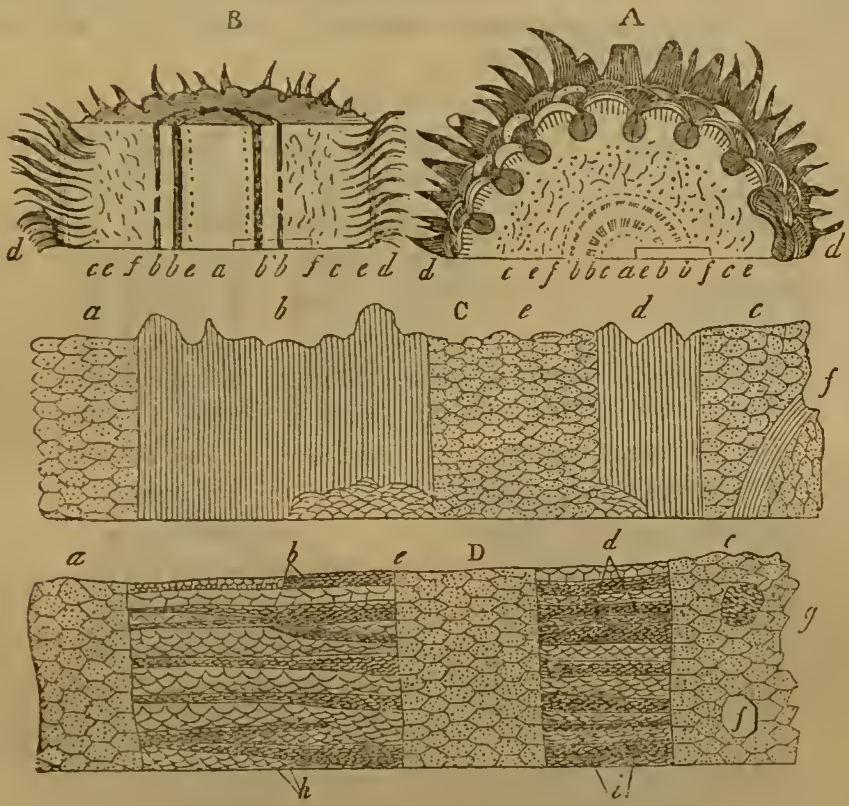
(1373.) In *Cycas* and *Zamia*, which, with the fossil (*Cycadeoideæ* or) *Cycoidaceæ*, constitute the order ZAMIALES, one bud alone, and that terminal, is normally developed. In the axillæ of the leaves, just as in the axillæ of palm-leaves, and the scales of bulbs, other rudimentary gems exist, but under ordinary circumstances they remain abortive. By art, however, these buds have been excited, and the plant propagated from such a scale; and further observation may not improbably reward the assiduous for their trouble by discovering a ramified Cycas or Zamia, in which, as in the *Doum Palm*, they are naturally evolved.

(1374.) The terminal bud in the *Cycases* and *Zamias* [§ 85, C, D,] being alone developed, their stems of course are simple, like the stems of unbranched palms, and like them also they are crowned with tufts of divided leaves called pinnato-sected or wing-cut. The venation of their foliage is linear, and not reticulate; the leaves few and large; and, when they fall, the stem is left covered by their remains or scars. These are all points of strong similitude with palms and ferns: here, however, their analogy with the *Palmæ* ceases, but with the *Filices* they have one more character in common, for the vernation of the leaves is circinnate, like that of the fronds of ferns; yet not bearing the fructification on the backs of expanded peduncles, as in the Pteridales, but on still further metamorphosed organs, and in congested spikes resembling in some respects the cones of the Equiseta. From all the ferns, notwithstanding their strong similitude, they are however distinguished by an important peculiarity, which brings them back much closer to the palms, viz. the greater development of stamina and pistils, and the formation of a cotyledonary seed.

(1375.) The organs of fructification are nevertheless peculiar to this order and the other which is associated with it, viz. the Pineales, and differ greatly both from palms and every other vegetables known, and in their organs of vegetation there are striking peculiarities also. A section of the stem of *Cycas* or of *Zamia* [§ 1376, also § 1393,] shews, instead of the unstratified textures of the Endogenous plants, a regular series of concentric woody circles formed of tubes and cells, surrounding a central pith, and surrounded by an external series of different form, and size, and thickness, which constitute the bark or cortex. These strata are traversed from the centre to the circumference by medullary rays formed of plates of muriform tissue, which are tracts of communication from the outer to the inner pulpy strata, or, as they have been called, the internal and external piths.

(1376.) Each layer or stratum is found on examination to consist of a series of tubes accompanied by a series of cells, the cells in the wood being chiefly within the tubes, the cells of the bark chiefly without. These distinct strata consist of structures equivalent to those which in palms extend from the terminal buds to the roots for the supply of nourishment to the crown of leaves and fruit, and here they perform a similar function; but the buds in the Pinares, something after the

plan of Dracæna, deposit their yearly growths external to the older parts; not however external to all, but exterior to the old wood and interior to the old bark, a layer being added, annually or rather by each crop of leaves, to each, and thus increasing the stems in diameter, the older wood receiving the name of *duramen* or heart-wood, the newer that of *alburnum* or sap-wood; while the newer bark is called the *liber* and the older, the *volumen*.



Anatomy of the stem of *Cycas revoluta*. A. Transverse section of half the stem. (*a*) Medulla or central cellular tissue. (*b*) Internal thicker fibrous zone. ('*b*) External thinner ditto. (*c*) Cortical parenchyma, external cellular tissue, or external pith. (*d*) Bases of petioles. (*e*) Intercellular canals. (*f*) Fascicles of fibres passing from the external zone ('*b*) to the petioles.

B. Longitudinal section of stem; the references are similar.

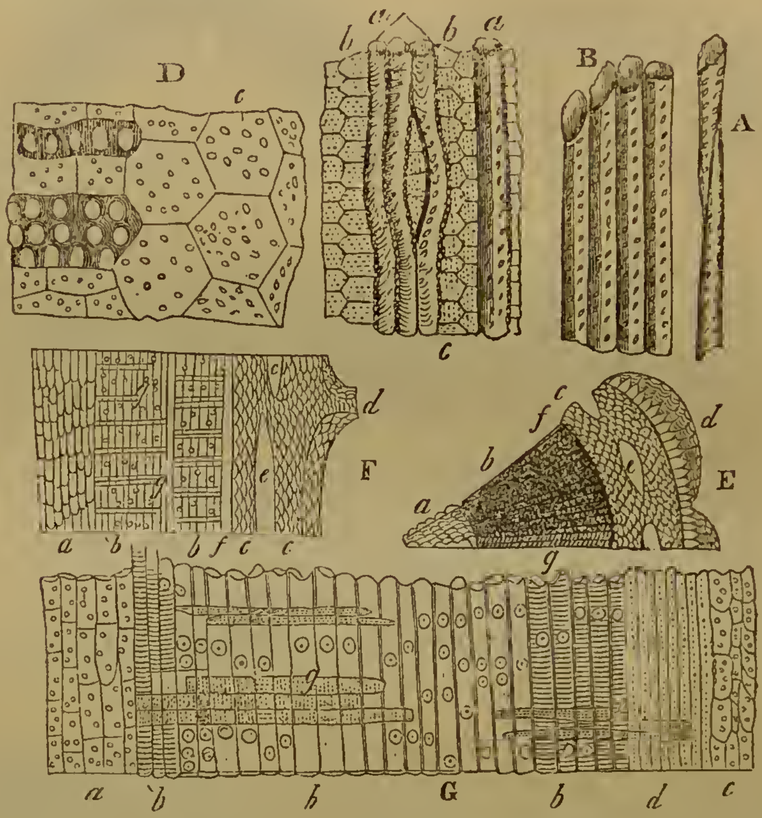
C, D. Portions of the longitudinal and transverse sections magnified; references similar. (*h*, *i*) Medullary rays.

(1377.) In the *Cycases* and *Zamias*, these layers are often peculiarly distinct, placed over each other like a series of cylinders, and, owing to the abundance of cellular texture, but loosely connected together, to what they are, in comparison, with their allies, the *Yews*, the *Cedars*, *Cypresses*, and *Firs*.

(1378.) The intimate structure of the vessels in this class associate the districts still more closely; and, as if to mark their affinity with ferns, the spiral tubes are in a very imperfect and rudimentary state; in some they are so few in number, that their presence has been absolutely denied. And, furthermore, the tubes of the wood in the Pinares are distinguished from the tubes of other plants by the extraordinarily large disk-like glands with which they are furnished, [§ 1379, A, B, G.]

(1379.) Adolphe Brongniart has published in the xvith volume of the "Annales des Sciences Naturelles," a very able monograph on the comparative anatomy of the stems of Cycas revoluta and Pinus picea. He well shews by extracts from various authors, how much truth is obscured by undue deference to authority,

A. Fibre of *Cycas* magnified, to shew the union of parts and the apparent pores or glandules. B. Several fibres taken in a direction parallel to the medullary rays. C. Fibres separated by medullary rays. (*a, a*) The fibres. (*b, b*) The medullary rays. D. Transverse section of fibres and medullary rays, and of the cells of the cortical parenchyma filled with fecula.



Anatomy of Abies picea. E. Transverse section of a yearly branch magnified. F. Longitudinal section of the same. G. Ditto of ligneous zone, much magnified. (*a*) Medullary cellular tissue. ('*b*) Fibrous zone of wood. (*b*) Fibres in contact with the medulla, which have been considered tracheæ on account of the transverse striæ. (*c*) Cortical cellular tissue filled with green granules. (*d*) Decurrent bases of the leaves. (*e*) Cryptæ, filled with resin. (*f*) Fibrous zones of bark. (*g*) Incomplete medullary rays. (The same letters of reference apply to the last three figures.)

and from neglect of reference to nature. For although Rheede, in his Hortus Malabaricus, had figured 150 years ago the stem of one of these plants as stratified, the example given having seven zones, modern writers of the highest eminence, amongst whom the two Richards may be mentioned, have uniformly described the internal structure to be unstratified, and similar to that of palms. And C. Richard, in his valuable Memoire on the *Cycadeæ*, says, in speaking of *C. circinalis*, (p. 187,) "Arbor . . . ligno albicanti, molli, uti in arboribus monocotyledonibus disposito." And Achille Richard, in following out the same opinion,

adds, "Ce stipe a la forme et l'organisation de celui des Palmiers, c'est-à-dire qu'il se compose de fibres réunies en faisceaux, et éparses au milieu du tissu cellulaire."

(1380.) It is evident, as Brongniart continues, that the above descriptions are those of the stem of the Sagus Rumphii, or some true palm; they are utterly inconsistent with the structure of any of the Zamiales. It is however extraordinary that Rheede's figure should have been stigmatized as incorrect, without examination, when it could so easily have been verified, the plants being cultivated in almost every conservatory in Europe.

(1381.) Dr. Buckland was one of the first to indicate the true structure of the *Cycadeæ*, in his examination of certain fossil plants, the natural affinities of which he was anxious to establish, and which he has shewn to be allied to the Cycases, and hence has named *Cycadeoideæ*. His figures are given, [in § 1393;] but they are far less satisfactory and copious in their details than those of Brongniart. [§ 1376 and 1379.]

(1382.) The general structure of the Zamiales and Pineales, as associating them with the other Crescaffines, has now been described. Their chief differences have been ably given by Brongniart: he says the Coniferæ differ from the true dicotyledons, by the nature of the tissues which form the ligneous strata of their stems.

These strata are scarcely separated into distinct fascicles, as the medullary rays are very narrow, incomplete, and scarcely visible. [Vide § 1379, fig. E, F, G.] The fascicles contain only one kind of tissue, consisting of elongated, pyriform cellules, all alike, analogous in their form to those which compose the wood of dicotyledons, but differing by their large glandular disks, which have been mistaken for pores; each is compassed with a border. In pine wood there is found, he adds, no trace of porous ducts, or false tracheæ, which are so common in dicotyledons.

He likewise believes that there are no true tracheæ, or spiral vessels, in these trees; for those which approach the nearest to them in appearance are not capable of being unrolled, and seem to be only a slight modification of the ordinary woody fibre, marked by transverse lines.

(1383.) These peculiarities, which distinguish the Coniferæ or Pineales from the other dicotyledons, are found likewise, with some modifications, to prevail in the Zamiales also. The chief differences are the great development of the parenchymatous system in the Cycases, while it is small in relative proportion in the Pineales; the medulla of these being scarcely visible, and the medullary rays imperfect, while in those the pith is so abundant, that it is extracted for economical purposes, and used as sago. The cortical parenchyma is in a similar way unequally developed.

The ring of fibrous tissue, on the contrary, which forms the most decided wood of the Pineales, is as it were degenerate and narrow; but still there are some of the Coniferæ, as the *Gingko biloba* or *Salisburia adiantifolia*, in which the cellular structure is more developed, and the woody zone less evolved; thus shewing an approach to the Zamiales.

(1384.) The most notable difference, however, in the organization of a stem of Cycas and a yearling branch of Pine, consists in the presence of fibrous liber in the latter, which fibres, if present, are not obvious in the former. They are, it

is true, very few in the pines; but upon this difference probably depends the difference of their growth.

(1385.) Another point of similitude and difference also deserves mention, viz. the cryptæ, or receptacles for proper juice, found in the external parenchyma: in the one case they are receptacles of gum or mucilage, and in the other of resin.

The two orders of the class Pinares, viz. the pines (or *Pineales*), and the Cycases and Zamias (or *Zamiales*), including in the latter group only the genera just named, and in the former the yews, firs, cedars, larches, and their allies, that have already been shewn to agree in so many particulars, exhibit a still further congruity in their organs of fructification, which are far less developed than in other flowering plants; indeed, but little raised above those of the [jointed ferns, or] Equisetales. For in both the spores or seeds are naked, having no closed pericarps; the leaves from which they should be formed being contracted into scales, that remain open and expose the ovula they bear. These ovules, however, are frequently invested with hardened persistent bracteæ, forming a false fruit called a cone or strobile, or occasionally becoming more or less succulent, as in the miscalled berries of the juniper (*Galbulæ*), and the yew (*Taxulæ*.)

(1386.) As a practical illustration of the series of changes which naturally occur in the several groups of plants, and which not only characterize the various classes and orders, but mark the successive evolutions of structure, a more beautiful instance can scarcely be found than that which has been pointed out by Brown, in his observations on the seeds and organs of fructification of the Pinares.

(1387.) In the Ferns, the organs of reproduction are seated either in conceptacles in the axillæ of the leaves, or on the back of the fronds, often contracted, as in *Lomaria, Osmunda, Ophioglossum,* &c. [§ 863,] to the form of scales, or sometimes within successive whorls of scales, forming a spike or catkin, as in *Equisetum*, [§ 68, D,] where rudimentary ovules and stamina are supposed to exist. In *Zamia*, the cones are formed of whorls of contracted leaves, bearing in the one case anthers, or perhaps naked pollen, and in the other ovules, the carpellary leaves on which they are borne not folding together, or uniting by their edges, to form a pericarp.

(1388.) In the Pineales, the leaves which form the strobiles or cones, are more fully developed than those which constitute the ordinary foliage of the plant. They are collected on a common elongated receptacle, or rachis; some are evolved as bracteæ, and others as antheriferous and ovuliferous scales; the ovules, whether few or many, always being exposed, and receiving the influence of the pollen immediately through the foramen, which was formerly mistaken for a sessile stigma.

(1389.) In the capillary leaves of the Zamiales, the ordinarily compound foliage is reduced to the form of scales, equivalent to those which result from the higher development of the simple leaves of the Pineales: in the one case, an extra evolution; in the other, a reduction being required to bring the ovuliferous scales to the same condition. Furthermore, in the Zamiales the pollen is probably naked, an opinion advocated by Linnæus; but in the Pineales it is enclosed in membranous sacs, although the scales which bear it are scarcely converted into anthers.

(1390.) The ovules in the Pineales are furnished with one, two, or even (ac-

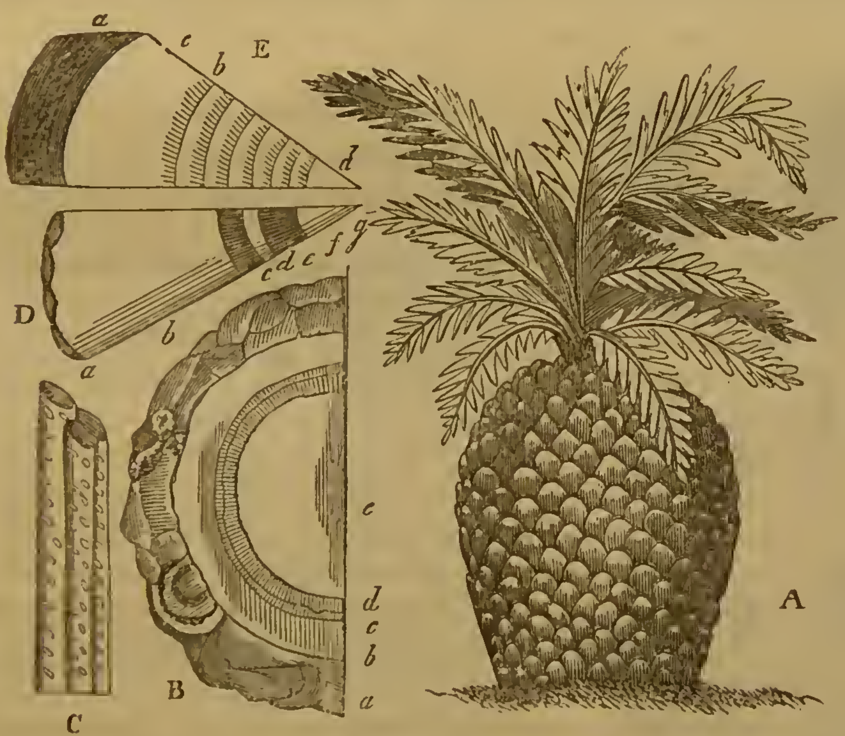
cording to Brown) in some rare cases, with three tunics, or proper seedcoats (testa and tegmen;) and the embryo, accompanied with horny, fleshy, or oily albumen, possesses two, three, four, or even as many as ten cotyledons; and the radicle, instead of being enclosed within a case, through which it bursts in germination, as in the *Endogenæ*, hence called also *Endorhizæ*, is here blended with the albumen, and undistinguishable from it; and therefore it is that these plants have been termed by Richard *Synorhizæ*.

(1391.) Their many cotyledons have given them in part the name of *Polycotyledones;* and, from their destitution of pericarp, they have been termed *Exogenæ Gymnospermæ* or naked-seeded plants, to contrast them with the other classes in which seed-vessels are present, and which are hence called *Angiospermæ*.

(1392.) Differentially considered, the Pinares are therefore gymnospermous or naked-seeded Exogenæ, with glanduliferous wood, and leaves having a linear venation.

ZAMIALES.

(1393.) This order includes but two, or at the most three, genera, and it neither requires nor admits of distribution into sec-



A. *Zamia horrida*. B. Transverse section of the stem, to shew its stratified structure. (*a*) The bases of the leaves. (*b*) The bark. (*c*, *d*) The new and old wood. (*e*) The voluminous pith. C. Glanduliferous [apparently porous] ducts. D. Section of *Cycas revoluta*, in possession of Dr. Brown, and figured by Dr. Buckland, to shew its concentric strata. E. Ditto of *C. circinalis;* the *Todda panna* of the Hortus Malabaricus, copied from Rheede, shewing seven laminated circles.

tions; for two of the genera, viz. *Zamia* and *Arthrozamia*, differ so little that they are most frequently united into a single genus: and *Cycas* bears so much similitude to both, that it is associated with them in a common type. The characters, therefore, of the type *Cycadaceæ*, and of the single section *Cycadinæ*, differ not from those of the order Zamiales, of which they are the sole contents.

(1394.) The *Zamiales* are exotic plants, having, as already observed, very much the general port and appearance of arboreous ferns or palms. [85, c, d; 1393, a.] Their stems are simple and branchless, rough with the scars of the successive crops of frondlike leaves, which are pinnate, and have a linear venation, the vernation being gyrate. The flowers are constantly diœcious; the stamineous ones being monandrous, achlamydeous, and collected into aments, which are sometimes very large. Each flower consists of a single staminiferous leaf or scale, not formed into an anther, but bearing the pollen exposed on its under surface, and associated in groups occasionally of twos or threes, but generally of fours.

The pistilline flowers differ in their modes of inflorescence. In *Zamia* and *Arthrozamia* they are collected into cones, the scales of which are thick and peltate, each bearing two flowers reversed. In *Cycas*, the inflorescence somewhat

Cycas circinalis.

A. Stamineous flowers.

(*a*) Entire cone, composed of antheriferous scales.
(*b*) Vertical section, to shew the rachis and exsertion of the scales.
(*c*) A scale detached, shewing the surface.
(*d*) The same, shewing its extremity.
(*e*) Ditto, shewing the polliniferous surface.
(*f*) A cluster of pollen.

B. Pistilline flowers.

(*a*) Rachis, or reduced leaf, bearing naked ovules on its edges.
(*b*) An ovule detached.
(*c*) A longitudinal section of a seed, shewing its coat and stigma-like foramen.
(*d*) Another view of the tubular foramen.
(*e*) Embryo detached.
(*f*) A transverse, (*g*) a longitudinal section of the seed, shewing the embryo within the albumen.

resembles the terminal fructification of the frondose ferns, the flowers being seated in depressions on the edges of contracted leaves or spadices, which thus assume rather the functions of fronds than leaves.

The ovules in both genera are naked, *i. e.* are destitute of pericarp, the carpellary leaves remaining in a rudimentary state, and the seeds have therefore no proper seed-vessel, nor any further covering than the scale to which they are attached. The ovules consist of a nucleus and one coat only; the embryo is seated in the midst of a fleshy or corneous albumen, and consists of two unequal cotyledons, which sometimes cohere; and the radicle is next the apex of the seed, is furnished with a long funiculus, and united to the albumen. The internal structure of the stem is decidedly exogenous, the strata loosely connected, and with much cellular structure and medulla. The ligneous tubes are glanduliferous, and apparently perforated; the whole of the plants likewise abound with farina and mucilage, and are devoid of resin.

(1395.) Differentially considered, the Zamiales are Pinares with simple stems, divided leaves, gyrate vernation, and mucilaginous secretions.

CYCADINÆ.

(1396.) Cycadaceæ. Only five species of *Cycas* have been hitherto discovered; and they are all natives of warm countries, such as China, Cochin-china, Japan, the Molucca Islands, New Holland, New Ireland, and the isles of the South Sea. Two of them, viz. *C. circinalis* and *revoluta,* yield abundance of sago; that from the latter is very much esteemed as food, and the plants are cultivated in China and Japan as affording a staple article of diet: in many parts the pith of this species, or of the former, is the chief sustenance of the native Indians for three or four months out of every year. The fruit is also eaten in the Moluccas, and in Japan; it is however necessary to have it roasted or prepared in some similar way, as when eaten raw it is very astringent, and the kernels are said to have emetic powers. Labardiere states, that when steeped in water and fermented, a spirituous liquor is procured from the fruit of the *Cycas circinalis,* and that the fruit-bearing trees yield a white gum something like gum tragacanth, but more soluble. According to the experience of Captain d'Urville, it would appear that the young buds or cabbages of these palm-like plants are deleterious, for he states that two of his sailors were poisoned by eating one of them when in New Guinea.

(1397.) Seventeen species of *Zamia* and *Arthrozamia* have already been discovered; nine of which differ from the remaining eight in having the foliola articulated with the rachis of the frondlike midrib, and thus constituting the genus or subgenus *Arthrozamia;* while those in which the foliola are confluent with the rachis form the genus *Zamia.* A further difference has also been pointed out, viz. that in the former there is a preparation in the rudimentary stamen to form a two-celled anther, while in the latter the pollen is not disposed in two-lobed masses.

(1398.) *Zamia Cafra* is the *brood-boom* or *bread-tree,* of the Hottentots. Thunberg first noticed the profusion of pith the trunk of this tree contains; and Sparman says that the *Caffrarians* extract this sago-like substance and bury it wrapped up in calf-skins for several weeks, by which it becomes much softened, and then, when kneaded with water, they make it into bread.

(1399.) All the Zamiales contain mucilaginous juices, which, in their natural

state, have a nauseous odour and unpleasant taste, owing to a peculiar extractive matter that is readily removed by steeping in water, or by heat, or other processes of cookery, when they form agreeable and nutritious food.

PINEALES.

(1400.) Although varying considerably in size, some being among the most colossal vegetables known, and others small shrubs, the Pineales are none of them herbaceous, but all arborescent ligneous plants.

Pinus pinea.

A, *a.* Staminiferous ament. (*b*) A staminiferous scale isolated, and viewed from above. (*c*) Reversed view, to shew the anthers and pollen. (*d*) A seed germinating. (*e*) Embryo, to shew the numerous cotyledons. (*f*) Section of a mature seed-bearing cone, to shew the rachis, the scales or metamorphosed leaves, and the seeds.

B. Branch bearing cones in different stages of development. (*a*) Vertical section of a young pistilline cone. (*b*) The carpellary scale isolated, to shew its unclosed state and the two uncovered ovules at its base. (*c*) Side view of a carpellary scale. (*d*) A longitudinal section of the same. (*e*) Transverse section. (*f*) Scale detached from a ripe cone, shewing the mature seeds. (*g*) Seed with the wing-like scale removed. (*h*) Nucleus with the testa removed. (*i*, *k*) Vertical and transverse sections of the seed, to shew the embryo included within the albumen. (*l*) Ditto, more highly magnified.

Contrary to the normal condition of the Zamiales, they develop many buds, and hence their stems are more or less divided, and the branches often numerous. Their leaves are simple, with a linear venation, generally acerose or lanceolate, and for the most part persistent ; the Larches and the Gingko being the only ones which are not evergreen. The foliage is sometimes in the form of imbricate lanceolate scales, resembling the leaves of the Lycopodiaceous ferns; at others the acerose leaves are collected into fascicles from the abortion of the axis of the branch, and then they are surrounded by a degenerate primordial leaf in the form of a scarious sheath, which bears some analogy to the *reticulum* of the palms, and the *ochrea* of polygonaceous plants. The flowers are separated, either monœcious or diœcious, and generally disposed in cones or catkins. The stamineous flowers are either monandrous or monadelphous, the anthers are two or more lobed, with an extrorse dehiscence: the stamens shew their rudimentary condition by frequently having an unconverted portion of the scaly leaf from which they are formed remaining as a crest. In the pistilline flowers the ovule is uncovered, the pericarpial leaf being either as in the solitary flowers, such as the yew, abortive, or, as in the coniferous sections, spread open in the form of a scale, and being destitute of style and stigma. The ovules in the true Coniferæ are in pairs on the face of the pericarpial scale, and inverted; in the others erect. The nucleus is invested with one or two membranes which remain open at the top, so that the access of the pollen is immediate. The fruit consists either of a solitary naked seed (Taxnie), as in the Yew, or of a galbule, as in the Cypress, or of a true scaly cone, as in Pinus. The seeds have a hard crustaceous testa, sometimes furnished with a wing, and the embryo, which has two opposite, or from two to ten whorled cotyledons, is placed in the midst of a fleshy and oily albumen, and is synorhizous, *i. e.* the radicle which is next to the apex of the seed is united organically to the albumen. [See also § 1394, 1431, 1411.]

(1401.) Hence it will appear that, although agreeing in numerous particulars with the *Zamiales*, this order, differentially considered, may be known by being resinous *Pinares*, with branched stems, simple leaves, and non-gyrate vernation.

(1402.) The elder Richard, who published a very learned dissertation on these plants, has distributed the order into three subordinate groups or sections, which, from the Fir, the Cypress, and the Yew, the normal genera of each, have been called respectively the Abietinæ, the Cupressinæ, and the Taxinæ.

(1403.) In the Abietinæ are included all the genera in which the pistilline flowers are reversed, and whose fruit is a true scaly cone.

(1404.) In the Cupressinæ are found all those Pineales in which the pistilline flowers are erect, united many together in the axillæ of scales, which are few in number, and form frequently a fleshy galbulus.

(1405.) In the Taxinæ are comprehended the remaining genera

in which the pistilline flowers are distinct from each other, attached to a scale or in a cup; and the fruit a simple naked seed.

ABIETINÆ.

(1406.) Linnæus blended the true Pines, the Firs, and the Larches, in a single genus. The propriety of this union, which was however always questionable, can now no longer be defended, and botanists in general have agreed to recognize those distinctions which have long been popularly established. The Pini of Linnæus are therefore now distributed into the genera *Abietes* (or Firs), *Pini* (or Pines), and *Larices* (or Larches), which, with *Dammara*, *Araucaria*, and *Belis*, form the section Abietinæ, and they differ so little from each other in essential points of structure, that they are all associated in the single type *Pinaceæ*.

(1407.) Pinaceæ. Some of these plants appear to have originally derived their names from the places of their growth, and, being mountain-trees, were called Pines, from the Celtic *pin* or *pen*, a rock or hill; like as our towns, Pen-ryn, Pen-rith, Pen-maen; and the Spanish ones, *Penna-flor*, *Penna-fiel*, and others, have been so called, either from being built on hills, or embosomed in the mountains. And this word, as the common root, can be traced through many languages: thus, *Pin* in Armoric and modern French, *Pino* in Spanish and Italian, *Peigne* in Erse, *Pinua* in Welsh, *Pinu* in Anglo-Saxon, *Pine* in English, *Pyn-baum* in German, and *Pyn-boom* in Dutch, are all evidently but variations of one root. Others, as *Belis*, have been so named from the javelin-like appearance of their leaves; while *Abies* is whimsically conjectured to be a derivative of *abeo*, to depart; an ejaculation of wonder at the extraordinary height these Firs attain, converted into a generic name; but it is more probably a corruption of the Celtic *abetoa*, or the Greek *ἄβιος*, as Hesychius calls the fir-tree *Ἀβιν*.

(1408.) The Firs (*Abietes*), are at once distinguished from the true *Pines* and *Larches*, by their pyrimidal growth and solitary leaves; as well as by the scales of the cones being slender and rounded.

(1409.) The species associated to form the genus *Abies* are distributed into two subgenera, which are familiarly known as the *Spruce* and the *Silver Firs*. In the Silver Firs (*Piceæ*), the leaves are all turned to one side of the branches, while in the Spruces (*Abietes*), they are spread equally all round.

(1410.) The most important species of spruce firs are the Norway Spruce (*A. excelsa*), the black and red spruces of Canada (*A. nigra et rubra*), and the Douglas spruce; the A. alba and orientatis are of much less value, the timber being of inferior quality, untractable, and subject to the worm; and the A. Menziesii, although well spoken of, has not been hitherto sufficiently proved to be safely recommended. The Canadians procure the thread with which they sew together the birch-bark their canoes are made of from the root-fibres of the white spruce, and with its resin the seams are rendered water-tight. The bark of this, as well as of other species, has been occasionally used for tanning.

(1411.) The black and red spruces, which are believed by some botanists to be merely varieties of the same species, afford most valuable timber. They are natives of some of the most inhospitable regions of North America, giving them a dark and dismal aspect, whence they have been called black swamps, or black-wood lands. Vast quantities of these timbers are annually exported from Canada to Europe. For example, in one year (1831) there were shipped at Quebec

			£.	s.	d.
Spruce and pine deals twelve feet by three inches thick, and eleven in width	16,466,795	Valued on the spot without freight at	104,105	9	2
Boards and planks	107,108				
And from New Brunswick, super. feet 21,782, equal to deals of three inches	800,740	Ditto	50,000	0	0
			154,105	9	2

From the spray of these firs is extracted the essence called spruce, with which that wholesome beverage, spruce beer, is made. Lambert's informant was in error when he stated that the essence of spruce is procured from the A. alba, the leaves and spray of that fir being carefully avoided on account of their unpleasant flavour. The roots of both the black and red spruces are used as well as those of the white, as thread, by the Northern Indians, to stitch together the sheets of birch with which their frail-looking but invaluable canoes are built. The roots merely require splitting when too thick, and after moistening are twisted into thread, which is preferred in Canada to European twine and cordage.

The *Abies Douglassi*, named after its enterprising discoverer, is a most noble tree, growing to the height of from 150 to 180, or 200 feet, and being occasionally found to exceed eight-and-forty feet in circumference. It yields abundance of fine clear resin, the timber is heavy, firm, of a dark colour, and not liable to warp. It is likewise a very quick growing tree, hardy, and, by the praiseworthy exertions of the Horticultural Society, it will no doubt be common in a very few years in British forests and plantations.

(1412.) The Norway spruce (*A. excelsa*), supplies in Europe the place which the *A. nigra* and *rubra* fill in America. They chiefly differ in aspect from the Norway spruce by having branches which spread almost horizontally, while those of European species are pendent or incline towards the earth. This fir abounds in the north of Europe, and its timber is exported in enormous quantities from the various parts of Russia, Norway, and Denmark. The *Christiana* deals are the most esteemed, and bear the highest price. In 1828 we imported from Norway, chiefly from Christiana and Bergen, 5170 battens and batten-ends; 11,229 deals and deal-ends; 3721 masts, yards, &c. under twelve inches diameter, and 13,506 loads of timber eight inches square or upwards. In the higher latitudes of Siberia, where this spruce abounds, it is considered by the wandering tribes as a certain sign of the presence of springs of fresh water, for, according to Gmelin, it is only met with in the neighbourhood of springs or in moist places.

(1413.) Of the Silver firs (*Piceæ*), the most important species are the *A. balsamea*, *Canadensis*, *nobilis*, and *Picea* or *pectinata*. The *A. Smithiana*, or Indian silver fir, is chiefly remarkable for its enormous size, the Abies *Brunoniana*, from its leaves being peculiarly deciduous, which is rare among these plants, and

the *A. religiosa,* which is the sacred fir of Mexico, from its branches being used to adorn churches and in religious ceremonies. It is not known that any of these afford valuable timber; indeed, the wood of several is of very inferior quality, as is also that of Abies *Sibirica* and *grandis,* the latter of which grows to the height of upwards of 200 feet.

(1414.) From the *A. Webbiana,* which is a native of Northern India, a purple pigment resembling indigo is extracted; it is there called *Oumur.* The bark of the *A. canadensis* is more valuable than its wood; the latter is fit only for the fire, but the former is said to equal oak-bark in its tanning powers. In Canada and the United States it is greatly used, and even preferred to oak-bark, for tanning sole leather; but, according to Mr. Gould, although "small consignments of it have occasionally been made to London, the tanners could not be induced to give it a trial." Its spray yields freely the essence of spruce.

(1415.) The *Abies balsamea* or balm fir, yields the famous Canada balsam. This turpentine or balsam is found in the numerous cryptæ of the bark, whence it is extracted by incision, and received into shells or cups. When I visited the village of Indian Lorette, says Mr. Gould, in his interesting Essay on the Pines of Canada, in 1828, two of the chiefs, who had been in England two years before, were then absent collecting it. Perhaps there is not a better varnish for water-colour painting than is prepared from this liquid resin. The branches of this, as well as of the hemlock spruce, are used by the Indian and Canadian voyagers to sleep upon. In their winter journies they scrape the snow together with their snow-shoes, making a kind of wall on each side of their lair, and then strewing the ground with branches, wrap themselves in their blankets; thus defended, they sleep in security when the thermometer is many degrees below zero. In this way, between two Indians, did Captain Thompson sleep, in his unsuccessful attempts to overtake Captain Franklin in his arctic journey. This is one of the few firs that will bear clipping well, and hence it is adapted for screens and hedges.

(1416.) The *Abies picea* (or Picea pectinata), is the sapin of the French, and, as its name imports, it abounds with resin, which is commonly known as Burgundy pitch and Strasburgh turpentine. It is a very handsome tree, and is probably the *Abies pulcherrima* of Virgil; for, although common on the continent, it is not a native of England; and the *Abies* is one of the trees which Cæsar states he did not find in Britain.

(1417.) The Larches (*Larices*), are scarcely distinguishable generically from the firs, and by some botanists they are included in the same genus, Abies, of which they form two further sections. But as the Larches and the Cedars, although they agree in having the scales of the cone slender and rounded like those of the firs, differ in the fasciculate arrangement of their leaves, and in the ovule foramen being cleft as in *Pinus,* and not hemispherical and cupped as in *Abies,* it is more convenient to associate them as a genus or subgenus, thus distinguished from the firs in which the leaves are solitary.

(1418.) The Larices are distributed into two groups, the *true Larches,* in which the leaves are deciduous, and the *Cedars,* which are evergreen.

(1419.) The common larch is the most valuable of all the species associated to form this small subgenus. *Larix pendula* is chiefly remarkable for the graceful curve its leading shoot assumes, drooping towards the ground when about fifteen or twenty feet in height, and forming a natural arch of extreme elegance and

beauty. The red larch (*L. microcarpa*), is a handsome tree, but very slow in its growth, and hence not so well suited as the common species for profitable planting. Its wood is dense and heavy, so that it will scarcely float in water. The common larch (*L. Europea*), is a noble and hardy tree, growing freely on the mountains of central Europe, and even as far north as Siberia. It seems to delight in exposed barren situations; and in Siberia it forms vast forests, sparingly intermixed with firs and pines; for, contrary to the habits of the Norway spruce, it is intolerant of wet and swampy situations. The timber of the larch is only second in value to that of the naval oak, and it has in many instances superseded the use of this latter wood, being much superior to most of the oak of foreign growth. The Dukes of Athol have planted the larch very extensively at Dunkeld, and their example has been followed by many patriotic persons in various parts of the British isles. The larch grows freely upon some of our most exposed and barren lands, forms timber rapidly, and is one of the most profitable forest-trees; for some grown at Dunkeld, when only eighty years old, yielded each six loads of the finest timber.

(1420.) Much prejudice has existed against the use of the larch in ship-building; and some persons have not scrupled to call larch vessels "leather ships," and "sailors' coffins." But the following statement, given by Mr. Gould, will shew that such notions could only have been founded upon ignorance. "In 1809, larch timber, grown by his grace the Duke of Athol, at Dunkeld, was first used in the British navy at Woolwich, in the building of the *Serapis* storeship, the *Sybille* frigate, the bottom of a lighter, and for piles driven into the mud, alternately wet and dry; and in all these situations proved a durable wood. The *Athol*, of twenty-eight guns, was also built entirely of larch timber from his Grace's estate; and at the same time the *Niemen*, of the best Riga. After their first course of service, on being examined, the *Niemen* was found in a decayed state, and condemned accordingly; whilst the *Athol* was again put into commission, and is at this time (December, 1832,) on a voyage to the West Indies. It was also remarked that, during the time this larch timber lay in Woolwich dock-yard, exposed to the weather, neither the heart nor the sapwood were in the least decomposed; nor was there the slightest appearance of fungi growing upon it."

(1421.) The bark of the larch is nearly as valuable to the tanner as that of the oak. Venice turpentine is the produce of this tree; it also yields a gum which is known as that of Orembourg. This gum is said to issue from the heart-wood, while the turpentine comes from the cryptæ of the bark: it is wholly soluble in water, like gum arabic, and supersedes its use in some few places. The mode in which this substance is commonly procured is remarkable. It occasionally happens that whole forests of larch, in different parts of the Russian empire, are consumed by fire, either accidentally or wilfully ignited. During the combustion this gummy matter issues from the inner parts of the trunk; it is diligently collected by the natives, who esteem it a delicate food. It is also supposed to be an antiscorbutic. Exudations also are found on these firs which resemble manna, instead of which they are used, under the name of *manna of Briançon*; but this manna is said not to have more than half the cathartic power of that of the East. The inner bark, when boiled, mixed with rye-flour, and buried for a few hours in the snow, furnishes the hardy Siberian hunters with a ferment, which they use instead of leaven, when that substance is spoiled, as it frequently is, by the severity of the cold.

(1422.) The Cedars, botanically considered, are evergreen larches, but the name *cedar* has been popularly given to several other trees besides those to which it of right belongs; such as the *Juniperus virginiana*, *Cypressus thurifera*, and even the *Cedrela odorata*. The cedar of Lebanon (*Larix cedrus*, or *Cedrus antiquorum*), is the most celebrated species; and next to it the sacred cedar of India, (*L. Deodara*.) The other associated species are but little known; they are the *L. Kæmpferi*, *Thunbergii*, *Torano*, *Araragi*, and *Momi*: the wood of the latter is white, and is much esteemed on account of the fineness of its grain.

(1423.) The *Deodara*, which the Hindoos call *Devadara* or *God-tree*, is a majestic cedar, which they hold in high veneration. Its wood is said to be extremely durable, and so full of resin, that strips of it are used instead of torches and candles. Spars of this cedar, in a sound condition, have been taken out of Indian temples, known to have been built from two to four hundred years. Mr. Lambert says its wood is close-grained, takes an excellent polish, and is perhaps one of the most valuable of the pines; certainly much more valuable than the timber of the cedar of Lebanon, which affords only an inferior sort of deal, that is very destructible. Cedar wood has long been famed for its durability; but such enduring timber was, it is confessed, the produce of other trees. Lambert conjectures that it was the wood of the *Cupressus horizontalis*; Sprengel believes it to have been that of the *Juniperus oxycedrus*; and Mr. Drummond Hay refers with still more probability to the *Thuja articulata*, which affords a beautiful, hard, deep brown, and almost indestructible timber. James II., when Duke of York, had a cedar table eighteen feet long and nine feet in breadth.

(1424.) The cedar of Lebanon, though not a lofty, is a very noble tree; its stupendous arms, each exceeding the bulk of ordinary forest-trees, spreading abroad on every side, give it an inexpressible magnificence of port. Mount Lebanon and the range of Taurus are the native places of these stately plants; but they grow freely in Britain, and various other parts of temperate Europe. This tree, which has been well called "the glory of Lebanon," would seem to have flourished on that mountain in former times in vast abundance; but, from the small number found there at present, it is conjectured by some antiquarians that they have never recovered the inroads which were made upon them by Solomon and Hiram, who did "all his desire concerning timber of cedar, and concerning timber of fir," and who had "fourscore thousand hewers in the mountains," besides "threescore and ten thousand who bare burdens;" and these men hewed "the cedar-trees out of Lebanon, and brought them down from Lebanon to the sea." Some venerable ruins, as memorials of bygone glory, however, yet remain, although they are so much lessened, that, as Isaiah says, a child may number them. In the year 1550, Peter Belon counted twenty-eight; in 1609, Litgow found but twenty-four; in 1650, Le Gouz reports that only twenty-two were left; in 1699, these, according to Maundrel, were reduced to sixteen; and, in 1789, Billardière states that seven were all that had escaped the ravages of time. Of these several were of enormous growth: according to Binot, they raised their proud summits to the height of sixty, eighty, or one hundred feet. Gabriel Sionita says that five men together could scarcely fathom the trunk of

one; and Maundrel, about one hundred and fifty years ago, found one of the largest, then quite sound, to measure twelve yards and six inches in girth. These relics of past ages, these memorials of the glory of other years, are now preserved with religious strictness, and the Maronites, a sect of Christians dwelling on Mount Lebanon, celebrate an annual festival under their patriarchal boughs, which is called "the feast of cedars."

(1425.) The true pines, like the firs and larches, have been distributed into three subgeneric groups, differing from each other in the number of leaves enclosed within the scarious vagina which is common to the whole, and by the presence of which, as well as by the scales of the cones being clavate and angular, instead of round and membranous, the *Pini* are distinguished as a genus from their associates, the *Larices* and *Abietes*.

(1426.) The *Scotch*,[1] the *Jersey*,[2] the *Corsican*,[3] and the *Aleppo*,[4] with the *dwarf*,[5] the *cluster*,[6] and the *stone*[7] *pines*, are examples of the *Pinasteres*, or those in which the leaves are found in pairs. Of the *Tædæ*, or three-leaved pines, the *frankincense*[8], the *fox-tail*,[9] the *Canary*,[10] the *swamp*,[11] and the *long-leaved*,[12] are the most important species. Of the *Strobi* or five-leaved pines, the *Weymouth*,[13] the *Siberian*,[14] the Nepal *excelsa* (Lambert's), and the *occidentalis*, are the chief at present known.

(1427.) The Scotch pine (*P. sylvestris*), is the only one of the genus indigenous to Britain, and here it is confined naturally to the northern parts of the island. At Invercauld, in Inverness-shire, and Gordon Castle, Aberdeenshire, are the largest and finest pine forests in the country. This tree is a native also of the Alps, and in the northern parts of Europe it is abundant, forming large woods in exposed and otherwise barren places. It will grow almost in any soil, but dry highlands are most favourable to the development of good timber. Two varieties of this pine afford the white and red deal of commerce; it also yields abundance of turpentine, resin, pitch, and tar. The resin is procured by wounding the tree, the tar by distilling the wood, especially that of the roots. Next to the larch, this species affords the most valuable and useful timber. Fir wood has always been esteemed for the manufacture of musical instruments, and it is from the timber of this pine that sounding boards and the breasts of violins are usually made.

(1428.) The bark-bread (*bark-broed*), of the Norwegians,

[1] P. sylvestris. [2] P. inops. [3] P. laricio. [4] P. halepensis.
[5] P. pumilio. [6] P. pinaster. [7] P. pinea. [8] P. tæda.
[9] P. serotina. [10] P. canariensis. [11] P. palustris. [12] P. longifolia.
[13] P. strobus. [14] P. cembra.

which Linnæus states the Laplanders eat during a great part of the winter, and sometimes even during the whole year, is a preparation of the inner bark of this pine. The bark for bread-making is selected from the older and least branching trees, for the young sprays and small branches contain too much resin; the alburnum is soft, white, fibrous, and succulent, and is stored up at those seasons when it separates easily from the older layers. When the natives are about to convert it into bread, it is slowly baked on the coals, and, being thus rendered hard and porous, is ground into powder, which, when kneaded with water, is made into cakes. The outer bark, which is light, is used by the fishermen, instead of cork, as floats for their nets. The young shoots when just beginning to appear are collected by the children of the peasants, and esteemed as food; when properly prepared, they form a wholesome and agreeable salad. They are also stored as winter fodder for the rein-deer.

(1429.) The Frankincense or loblolly pine (*P. Tæda*), overruns large tracts of land in the southern parts of North America: it grows freely in this country, and its timber is said to be superior to that of the Scotch species. The pitch and the Jersey pines (*P. rigida et inops*,) are among the most prolific of the whole in turpentine and resin: from the condensed smoke of the burnt wood of these, as well as of other species, when the pitch and tar have been extracted, lamp-black is procured. Pitch is extensively used in shipbuilding, and, mixed with whale-oil, it forms the various kinds of anti-attrition and grease for cart and carriage wheels.

(1430.) The Strobi are splendid trees; and one of the most noble is the Weymouth pine. It grows in Canada to the height of 150 or 200 feet, and is often found fifteen feet in circumference. Its age is unknown: 1500 strata have been counted in the trunk of one. From the large size of this pine, and the durability and tractibility of its wood, enormous quantities are converted into timber. It affords the largest masts for our men of war, and is much esteemed for water woodwork and water-courses. The almost impenetrable forests where these pines abound would seem to forbid their use by man; but, although perhaps not one in ten thousand of the trees, as they naturally grow, is fit to be cut even for common timber, so great is the demand, that roads of considerable length are made through the woods, for the purpose of conveying the timber from its place of growth to the nearest river. Large parties of men, called Lumberers, are engaged in these

enterprises: each gang, from thirty to fifty, is termed a *shanty*, (from the French *chantier*,) and requires an advance of from 1500*l*. to 2000*l*. to purchase horses, oxen, and provisions for men and cattle during the period of the adventure; for they are generally absent for seven or eight months, or more, in desert regions, where no help is.

(1431.) P. Lambertiana, which is a native of *California*, is a very majestic tree. One blown down, that Mr. Douglas measured, was 250 feet long and fifty-seven feet nine inches in circumference at three feet from the root; and he saw some of the same pines then standing which were larger. The timber is light and soft, and the resin, which is of a fine amber colour, becomes, when the wood is partly burned, converted into a sort of sugar, for which it is used as a substitute. The Canadian pines grow to a most stupendous height. Mr. Cox measured one whose trunk was 150 feet clear of branches, and the whole height not less than 300 feet. This monarch of the woods was worthily dignified by the Canadians under the title of "*Le Roi de Pins;*" but Mr. Cox found one in Columbia still larger, the trunk being fifty-seven feet in circumference, and 216 feet clear without branches. European trees seldom attain so immense a magnitude; but the Hedsor yew [§ 1446] is upwards of eighty feet in circumference; and Strabo mentions a pine upon Mount Ida which he says measured twenty-four feet in diameter. The seeds of *P. Lambertiana* and *Cembra*, as well as those of other species, are eaten, and in some places much esteemed.

(1432.) The New-Zealand kawrie (*Dammara australis*), the Norfolk-Island pine (*Araucaria excelsa*), and the other associated species and genera included in this type and section, differ not essentially in their properties and uses from those already described. Some of them are immense trees, rising, as does the kawrie, to the height of two hundred feet, and furnishing good timber. These are indeed what the poet so well describes as

> "Vast and giant models of their kind,
> Which in far distant regions of the globe
> Sequestered stalk, with lifted heads on high
> O'ertowering Atlas."

The Amboyna pitch-tree is the *Dammara orientalis;* the fresh fruit of *Araucaria excelsa* is eatable; and *A. imbricata* is both a curious and interesting plant, its closely imbricated foliage resembling a coat of mail.

CUPRESSINÆ.

(1433.) THUJACEÆ. The land of the Cypress has given its name to the trees

Juniperus communis.

A. Branch bearing pistilline flowers.

(*a*) Stamineous ament.

(*b*) Antheriferous scale.

(*c*) Pistilline ament.

(*d*) Vertical section of the same, to shew the erect ovules within the superior scales, the stigma-like foramina, and exposed nuclei.

(*e*) Ripe fruit.

(*f*) Section, to shew the seeds.

(*g*) Seed detached.

(*h, i*) Sections shewing the embryo included within the albumen.

(Cupressi, *κυπάρισσοι*), which chiefly abound in its forests, as well as to the metal (Cuprum, *κύπριος*), which was first extracted from its veins.

Cupressus, and its allies, *Thuja, Taxodium, Callitris*, and *Juniperus*, are associated to form the second section of the order Pineales, which, from the first named genus, has been called the *Cupressinæ;* and from the second, as they are all included in a single type, this type has been termed *Thujaceæ.*

(1434.) *Thuja*, the *arbor vitæ* or tree of sacrifice, was originally called *Thuya* (*θῦα*, from *θυω*), as its wood, from the pleasant odour it gives out when burned, was frequently used in sacrifices. The two species most commonly cultivated in this country are the Chinese and the American, (*T. orientalis* and *occidentalis.*) *Thuja pendula* [§ 51, B], from its sombre foliage and drooping boughs, has a very melancholy aspect, and is said to be planted by the Greeks in their burial-grounds as a symbol of mourning. In the black lands of the Missisippi (says Mr. Gould) there are immense tracts covered with the Thuja occidentalis, than which no prospect on earth can be more gloomy. It might have been supposed that the ancients who dedicated the Cypress to funeral rites had seen these "Dismal Swamps:" nothing so forbidding in the way of vegetation exists in Europe.

Here the Arbor vitæ seldom exceeds the size of a shrub, but in moist soils it becomes a large tree. In the wet clayey regions of America, especially those which are subject to frequent inundations, it becomes a timber tree, and, although a light wood, it is one of great durability. It is commonly known in commerce as *white* cedar, and is in much request among builders for cellar beams and posts, and for

piles in wet and trying situations. It seems to be a slow growing tree, for Michaux counted 277 concentric circles in a stem only twenty-one inches in diameter. The smaller branches and spray are made into besoms; and the leaves afford a salve which the Indians prize as a cure for rheumatism. Thuja articulata yields the gum sandrach of commerce; but that most esteemed is an exudation of the common juniper. Powdered gum sandrach is familiarly known as *pounce*, and is used for the purpose of preparing parchment for the pen.

(1435.) Of the Junipers, *Lycia*, *Sabina*, and *communis*, are the most important species. *J. Bermudiana*, *Barbadensis*, and *Virginiana*, are also valuable in the West Indies, as affording timber, which is brought to this country under the name of Bermudas Cedar. The last named is one of the highest timber trees of Jamaica; it yields large boards of a reddish colour, firm, shining, and very fragrant, and is hence much prized by cabinet-makers. *J. lycia*, by common repute, produces the gum Olibanum, which is supposed to be the incense of the ancients, and it is one of the gums employed by the Roman Catholics in their religious ceremonies, and used frequently to cover offensive odours in sick rooms. Olibanum, however, if yielded by the J. lycia, is not procured from it alone, another plant, the *Boswellia serrata*, being referred to by good authority, as the chief, if not the only source. J. Thurifera does not deserve its name, for it yields no frankincense at all.

(1436.) *J. sabina* is a powerful stimulant; but, although recommended as a diaphoretic and emmenagogue, yet as the Malthusian doctrines, although theoretically commended, are not practically enforced, it is seldom used except in the form of ointment to promote the discharge from blisters, or to cleanse foul ulcers and other unhealthy sores. The expressed juice of the leaves is said to be serviceable in the treatment of *tinea capitis*.

(1437.) *J. communis*, our only indigenous species, grows abundantly in most parts of Europe, and almost in any soil; granite rocks and sandy heaths, and fertile plains, appear almost equal to this plant. It is obnoxious to the growth of grass, none in general being found beneath it; but it is said that the *avena pratensis* will in turn destroy it. The wood of the Juniper is hard and durable, and its bark may be twisted into cables, but the chief use of the plant is to flavour ardent spirits. Hollands owe their taste to the so-called *berries* of the Juniper, and English gin is commonly believed to be flavoured with them also; but it is wholly unconscious of their presence, the British manufacturers of that 'cordial' poison being content with the substitution of oil of turpentine. Juniper berries are stimulating and diuretic, their properties depending on an essential oil which they contain: when boiled they yield a considerable quantity of sugar; and Linneus states that such a decoction, when fermented, forms a common drink in Sweden. From six to eight hundred tons are annually imported into this country, but the oppressive duty to which they are subject, full 100 per cent., limits their consumption.

(1438.) From cypresses growing most freely and luxuriantly in the Mediterranean isles, the temperature of which, from their situation, is remarkably equable, and the climate mild and healthy, these trees were formerly supposed to conduce to the salubrity of those countries, by purifying and renovating the air. Hence consumptive persons were sent to Candia and Cyprus, as places out of Attica where they had less chance to die. But, although labouring in the common occupation of withdrawing charcoal from the atmosphere, there is no evidence

that the cypress is more active than the other Pineales, although it is not improbable that the plants included in this order are, and have been, more energetic than any others save the Ferns.

(1439.) Both the leaves and the fruit of the cypress are bitter and astringent, and in old times were medicinally employed. Galen recommended their use to restrain various fluxes; but in the present day they are fallen into utter neglect. The common cypress has always been a favorite ornament in gardens, and the weeping cypress, from its melancholy aspect, devoted to the fellowship of the tomb. Its wood is not liable to be attacked by worms, and its durability is proverbial. Hence, according to Thucydides, the Athenians buried the bodies of their heroes in coffins of cypress wood, and from it, as not being subject to decay, they also made the statues of their gods.

The *Cupressus Thyoides* of North America is there called the white cedar, and it would seem that the timber of the European cypresses have often been likewise thus mis-named, which error may have led to a similar endurance being ascribed to the cedar which it does not in truth deserve. Thus Horace, in accordance with the popular opinion, attributes to its oil the power of ensuring durability:

——— " speramus carmina fingi
Posse linenda *cedro* et lævi servanda cupresso."

The imperishable chests that contain the Egyptian mummies were made of cypress wood, and the gates of St. Peter's church at Rome, which lasted from the time of Constantine to that of Pope Eugene IV. viz. eleven hundred years, were formed of the same materials, and had during that lengthened period suffered no decay.

(1440.) The cypress often attains a very large size; in Crete, Malta, and some parts of the Levant, it forms a common timber. In America also some examples are on record in which these trees have reached a most enormous magnitude. Thus, at Atlixo, there is a very ancient and remarkable cypress which is said to measure not less than seventy-six feet in circumference. The trunk is hollow, and the diameter measured inside is fifteen feet. But even this cypress, large as it is, shrinks almost into insignificance when compared with some individuals of an allied genus, now called *Taxodium* or *Schubertia*, the Cupressus disticha of Linneus.

(1441.) The Taxodium is a native of America, growing abundantly in the southern parts of the United States, and likewise in Mexico. In the gardens of Chapultepec is one called the Cypress of Montezuma, which was in full vigour when that prince was on the throne, in the year 1520. It is now forty-one feet in girth, and apparently only in its prime. But another, far more remark-worthy, is described by Exter, as standing in the burial-ground of *Santa Maria de Tesla*, which the inhabitants of Oaxaca call *Sabino*. There are several noble trees in the same place; the largest, however, is the vegetable wonder, measuring 117 feet ten inches (French) in circumference, thirty-seven feet and a half in diameter, and about one hundred feet in height. This patriarch of the woods was mentioned by Cortez, who encamped his little army beneath its shade; and it is regarded with reverence almost approaching to religious veneration by the native Mexicans. The height at which the admeasurements were taken is not mentioned; but, supposing them taken on the ground-level, there are several Taxodia mentioned by Michaux, as growing in the Floridas and Louisiana, which would nearly

equal the great tree of *Oaxaca:* for he says they gave forty feet in girth above a conical base three or four times as large as the columnar trunk. The mean age of the Taxodia has been calculated to be from 4000 to 6000 years; and if such computations be correct, which however is more than doubtful, the great tree of *Oaxaca* may be coeval with the creation. Or, as the poet says,

> "Its cold and lengthened tracts of shade
> Rose on the day when sun and stars were made."

TAXINÆ.

(1442.) TAXACEÆ. As in the two previous instances, the genera included in the section *Taxinæ* are all associated to form a single type, which, from the normal genus, is named Taxaceæ. There are, however, observable in this group three diversities of foliage, which, although perhaps not sufficiently important to be made typical characters, may be allowed to indicate three subtypes. Thus, in the Yew (*Taxus*), and its immediate allies, the leaves are acerose, in *Salisburia* they are flat and expanded, and in *Ephedra* they are absent; which variations may be taken as the differential characters of the *Taxidæ*, *Salisburidæ*, and *Ephedridæ*.

(1443.) The yew, of which we have but one, or at the most two, known European species, was formerly, before the invention of fire-arms, a most important

Taxus baccata.

B. Branch with fruit, and shewing the simple acerose leaves.
(*a*) Stamineous ament reduced to a monadelphous cluster.
(*b, c*) Upper and under view of the peltate antheriferous scale.
(*d*) Pistilline cone reduced to a single flower.
(*e*) Longitudinal section, shewing the naked ovule, the foramen, and the investing scales.
(*f*) Scales removed.
(*g*) Ripe fruit, shewing the ovules and half the succulent cupule, (or arillus?)
(*h*) Section of the seed.
(*i*) The nucleus.
(*k*) Section, to shew the embryo within the albumen.
(*l*) The embryo removed.

tree, as affording bows for our warriors; indeed, its very name, *Taxus*, is said to be derived from Τόξον, a bow; but yew is evidently a corruption of the Saxon *iw*,

green, and alludes to its sempervirence. So great was the demand for yew in the days of archery, that various laws were enacted concerning it from the time of the fourth Edward to the reign of Elizabeth. As our native produce could not supply the vast demand, it was imported in large quantities from abroad; and ships trading to Venice were obliged to bring ten bow-staves along with every butt of malmsey. The skill in the use of the long-bow was the proud distinction of the English yeoman, and it was his boast that none but an Englishman could bend that powerful weapon. By a statute of the fifth year of Edward the Third, every Englishman, and Irishman dwelling with Englishmen, was directed to have a bow of his own height; and it has been supposed that, to supply these arms, the yew trees so common in our churchyards were planted. This is, however, most unlikely, for in the first place the supply, from such sources, would have been far too scanty, and in the second, it is well known that the yew was in ancient times dedicated to religious purposes. Ray says it was planted by our ancestors, in churchyards, because as an evergreen it was thought to be a symbol of that immortality the dead hoped to enjoy. Branches of yew were likewise carried over the dead by the mourners, and thrown into the grave for the coffin to rest upon. The yew tree was also consecrated by the priests; and, by an extract from the ancient laws of Wales, it appears that the performance of the ceremony raised its value from fifteenpence to twenty shillings.

(1442.) The yew is one of the most tonsile trees we have; and hence, when the formal systems of horticulture were in vogue, yew hedges and yew images were in great repute. Few vestiges of this perversion of taste remain; between Henley and Oxford, however, there are two yew trees cut into the form of peacocks, and in Bedfont churchyard there are two others, which have now been upwards of a century and a quarter reduced to such an unnatural condition, their yearly shoots being annually clipped off; and there is no chance of escape for these metamorphosed trees, an annuity having been left by some eccentric person to keep these yews thus cut for ever.

(1445.) The wood of the yew is hard, heavy, and extremely durable. It is peculiarly adapted for floodgates, mill-dams, and other works in exposed and trying situations. Its knots, veins, and red colour, also render it a favorite with the turner and cabinet-maker.

(1446.) The yew is a very long-lived tree, and often attains an enormous magnitude. One in Braburne churchyard, in Kent, was nearly twenty feet in diameter; and at Sutton, near Winchester, there was (to use Evelyn's quaint language,) "such another monster." The Crowhurst yew, near Hastings, is thirty feet in circumference. The Fortingal yew, in Perthshire, when seen by Pennant, although reduced to a mere shell, was alive, and measured fifty-six and a half feet in circumference, or about eighteen feet in diameter; but in the woods of Cliefden there are some still more extraordinary remains of these trees; and one, called the Hedsor yew, still in health and vigorous, that measures twenty-seven feet in diameter, or about eighty-one feet in girth.

(1447.) The succulent coat of the yew-berry has a sweet and sickly taste; it is, however, wholly innoxious, although the seeds are said to be unwholesome. The leaves also are poisonous, at least to some animals; for, notwithstanding deer, sheep, and goats, are said to be able to feed on them with impunity, a very small quantity taken as food will destroy both cows and horses. Several fatal accidents,

shewing the poisonous properties of the yew-leaves, have within a short time occurred: in one of these, three horses, taken to be sold at a country fair, were tethered to the churchyard railings, over which some yew-boughs hung. The horses ate the leaves, and they all three were killed by their repast.

(1448.) On the authority of an Italian physician, it is stated that the yew-leaves, when administered in small doses to man, have a power similar to that of digitalis over the action of the heart and arteries, reducing the circulation, and, if persisted in for too long a time, or given in too large doses, to be as certainly fatal as foxglove. Yew is however reported to have one decided advantage over digitalis, by its effects not accumulating in the system; so that it is a much more manageable and equally efficient remedy. Such being the case, it is to be regretted that it has not been introduced into the British lists of medicines.

(1449.) The fruit of *Podocarpus nereifolius* is said to be eatable, as is also that of the Gingko (*Salisburia adiantifolia.*) The pulpy covering of the seed in this latter is, when ripe, of a bright yellow colour externally, with an inner, white, fleshy, juicy pulp. The kernel is white, rather firm and sweet, bitter if eaten raw, but agreeable in flavour when roasted. Dr. Abel informs us that he saw the fruit exposed for sale in the markets of China. It is a peculiarly interesting plant, as shewing, by the expansion of its leaves, an approach to the following class, as well as by their form and venation to the *Adianta* of the ferns.

Salisburia adiantifolia.

A. Terminal whorl of aments, with a central tuft of leaves.

(*a*) Ament.

(*b*) Pendent stamen.

B. Cutting, to shew the bilobed leaves, with linear dichotomous venation.

(1450.) *Ephedra*, which concludes this class, is still more interesting than Salisburia as an osculant genus; for the branches and branchlets are jointed, as they will be found to be in *Casuarina*, of the *Quernceales*, and also, as they have already been described to be, in the Equisetine ferns. [§ 896.] Indeed, from

its great resemblance to these plants, it has usurped their old Greek name; for Ephedra originally belonged to the horse-tails, as Hippuris to the mare-tails, and of it Equisetum is but the Latin version. *Ephedra monostachya* abounds

Ephedra monostachya.

c. Cutting, to shew the leafless articulate branches, with nodal sheaths.

(*a*) A joint, with its sheath.

(*b*) An ament.

(*c*) A flower separated, to shew its scales.

(*d*) Monadelphous stamens, denuded.

in Siberia; and *E. distachya* occurs both in France and in the southern parts of Russia. On the shores of the Mediterranean their berry-like fruits are called "raisins de mer," and they are considered both tonic and febrifuge. In Hungary and Siberia the fruit of the E. monostachya is eaten as a luxury; and Gmelin states that, in his travels, he was only too happy when he found them. Carver mentions another species of Ephedra, found on the borders of Lake Michigan, in the country of the Chippeway Indians, that bears fruit as large as a marble, and is called "the sand-cherry." He says these are much relished by the French, who preserve them in brandy, and make a sort of ratafie.

(1451.) Here concludes the general outline of the Pinares or *gymnospermous exogenous dicotyledons;* but, besides these, which are well ascertained to have naked seeds, upon which character the class is chiefly, although not wholly established, Dr. Brown believes that even *Gnetum,* of which *Thoa* of Aublet is a species, has a similar conformation, and, although the seeds have three coats, that they are destitute of a true pericarpium. If further investigations should confirm this belief, then *Gnetum,* from its extreme difference of habit, will become the representative of another type or section, connecting the Pineales still more closely to the other Crescaffines, and which might be called the *Gnetinæ;* but, as botanists have in general regarded one at least of the coats referred to as a pericarpium, it would not be expedient at present to disturb the ordinary arrangement, nor, without more extended investigations, to associate these plants with the Pineales.

(1452). This summary outline of the most important genera included in the several types and sections, is closed, as usual, with a

TABULAR CONSPECTUS OF THE CLASS.

PINARES 1392	PINEALES 1401	Taxinæ, Taxaceæ (1405)
		Cupressinæ, Thujaceæ (1404)
		Abietinæ, Pinaceæ (1403)
	ZAMIALES	Cycadinæ, Cycadaceæ (1395)

GEOGRAPHICAL DISTRIBUTION OF THE PINARES.

(1453.) From the colossal size and majestic port of the majority of the trees included in this class, they form a striking and characteristic feature in the vegetation of all countries in which they abound, and their distribution is nearly universal. But their prominent station is attributable rather to the peculiarity of their aspect, and the multitude of coexistent individuals, than to their number of species and genera, which is much less than the average proportion.

(1454.) Topographically considered, the two orders included in this class differ greatly in their range; for, while some of the Pineales are polar plants, extending to the regions of perpetual snow, the few Zamiales with which we are acquainted, like the palms and arboreous ferns, that in habit they so much resemble, are exclusively the natives of warm latitudes, and scarcely to be found without the tropics.

(1455.) China, Cochin-China, the East Indies, New Holland, the Moluccas, and Japan, are the countries to which the several species of *Cycas* are indigenous. *C. revoluta* has the most northern habitat of the whole; but Japan, in which it occurs, has a climate almost peculiar to itself: and is much more tropical in its temperature than in its latitude.

(1456.) The *Zamiæ* and *Arthrozamiæ* are so diverse in their distribution, that it is fortunate subgeneric distinctions are indicated by their structure. The true *Zamiæ* are denizens of the Old, the *Arthrozamiæ* of the New World. Hispaniola, Florida, and the various West Indian Islands, with the tropical regions of Continental America, are the native habitats of the species *muricata, furfuracea, debilis, integrifolia, media, pygmæa, tenuis, angustifolia,* and *pumila*; the foliola of which are articulated to the rachis or midrib of the leaf: while of the true *Zamiæ* none are found in the Western hemisphere; but the majority of the species belong to Madagascar and Southern Africa, especially to the neighbourhood of the Cape of Good Hope; one only, *Z. spiralis,* having been discovered in New Holland. It is remarkable, that, although the American *Arthrozamiæ* are all tropical, none of the true *Zamiæ* are found in the equinoctial regions of Africa, notwithstanding they are natives of the southern parts of the Peninsula and of the island of Madagascar.

(1457.) The three types or sections of the order Pineales have each a nearly equal extent of distribution, the difference of habitat occurring rather among the species and genera than among the larger groups. Of the three, the Abietinæ may have perhaps rather the most northern and southern range, but at the same time several of the tropical genera and species belong to this section; while the *Cupressinæ* and *Taxinæ* are chiefly extratropical, and found for the most part in the temperate regions.

(1458.) *Dammara Australis* and *Araucaria Braziliensis,* are among the few

tropical species of the *Abietinæ*, to which may be added the *Cedrus deodara* of Hindoostan, as well as the other pines of India, several of which, however, from their altitude if not latitude, verge in climate towards the temperate zones.

(1459.) The *Cedar*, the *Aleppo*, the *Cluster*, and the *Stone-pines*, are natives of the south of Europe: Pinus maritima, Laricio, and Romana, of Italy and the shores and islands of the Mediterranean; while the majority of the Pines, Firs, and Larches, are most common in the northern parts of the temperate and in the frigid zones, of either hemisphere. Thus *Abies excelsa* occurs in Norway, Sweden, and Arctic Russia. *A. nigra, rubra, alba, Douglassii,* and *Canadensis*, in North America; the *Common Larch* in the northern parts of Continental Europe, even extending to Siberia; and the *red* and *black Larches* in North America.

(1460.) Of the true Pines, the Scotch, the pigmy, and the Siberia stone, are all northern plants in the Old World, while *P. strobus, Banksiana, palustris,* and others, overspread parallel latitudes in America, reaching as far north as Hudson's Bay. *A. alba* was the most northerly seen in Franklin's polar journey.

(1461.) Of the *Cupressinæ*, *Taxodium*, which is found in Mexico, and *Cupressus*, several species of which are natives of Goa, Nepaul, Candia, and Japan, are the least northern genera. The *Junipers* and *Thujas*, although a few, as the Barbadoes and Bermudas cedars, are equatorial plants, or confined to the warmer regions of the temperate zone, extend far north, even into Siberia, and the polar climates of America.

(1462.) The *Taxinæ* are chiefly found in the warmer parts of the temperate zones. Thus, *Salisburia* and the *Podocarpi* are natives of China and Japan, *Dacrydium* and *Phyllocladus* of New Zealand and Van Dieman's Land; but the Ephedræ extend from the shores of the Mediterranean to Siberia, while one of the Taxi is found in China, one in Canada, and the common species are distributed throughout Continental Europe, Great Britain, and Ireland.

(1463.) Hence it will appear that of the Pinares, statistically considered, the *Zamiales* is the tropical, the *Pineales* the extratropical order. For, although some of the latter are equatorial plants, the majority are found in cold and temperate latitudes, and the former are unknown in the northern temperate and polar regions.

(1464.) The tropical Pinares are chiefly the *Dammaræ, Araucariæ,* some few *Pini, Cedrus Deodara, Juniperus barbadensis, and Taxodium.* Bordering on the tropics in either hemisphere the number of the Pineales is greater than within five and twenty or thirty degrees on either side of the equator, and as the parallels of latitude become higher, the prevalence of these plants becomes more decided, until in the north temperate and frigid zones they reach their climax; for, although not the last arborescent vegetables found, they flourish almost on the verge of perpetual snow.

(1465.) Some points of interest belong to the distribution of these plants in similar latitudes in the Old and New Worlds, and on either side of the equator.

The restriction of the *Zamiæ* to the western hemisphere, and of the *Arthrozamiæ* to the eastern, has been already mentioned, as well as the peculiar exclusion of the latter from the equinoctial regions of Africa, notwithstanding their abundance in Madagascar, and at the Cape of Good Hope; and the prevalence of the allied Zamiæ in equatorial America.

In the same manner the Cycases are wholly confined to the eastern hemisphere, although some are found on either side of the equator.

(1466.) A nearly analogous exclusive distribution occurs frequently among the *Pineales;* few genera and species having a very extended range, and a great difference is found even in similar latitudes in the northern and southern hemispheres.

To the north of the equator the Stone pines, the Firs, the Larches, Junipers, Ephedræ, and Yews prevail; while to the south they are superseded by *Araucaria, Dammara, Podocarpus, Dacrydium,* and *Phyllocladus.*

(1467.) Between the eastern and western hemispheres, a similar but minor difference is observable as between the north and south: in the one the diversity being often in genera, in the other more frequently in species. Thus, in the Old World we find *Abies excelsa, picea, orientalis,* and *spectabilis;* in the New, *A. alba, nigra, canadensis,* and *Douglassi:* in the Old World *Larix europea,* in the New *L. pendula* and *microcarpa;* in the Old World *Pinus sylvestris, Pinea, Pinaster,* and *halepensis;* in the New *P. Strobus, Tæda, serotina,* and others; in the Old World, Thuja orientalis: in the New, Thuja occidentalis, and similar illustrations might be given of the *Junipers* and of the *Cypresses,* but in this latter group the difference is generic, *Cupressus disticha* being now called *Taxodium.*

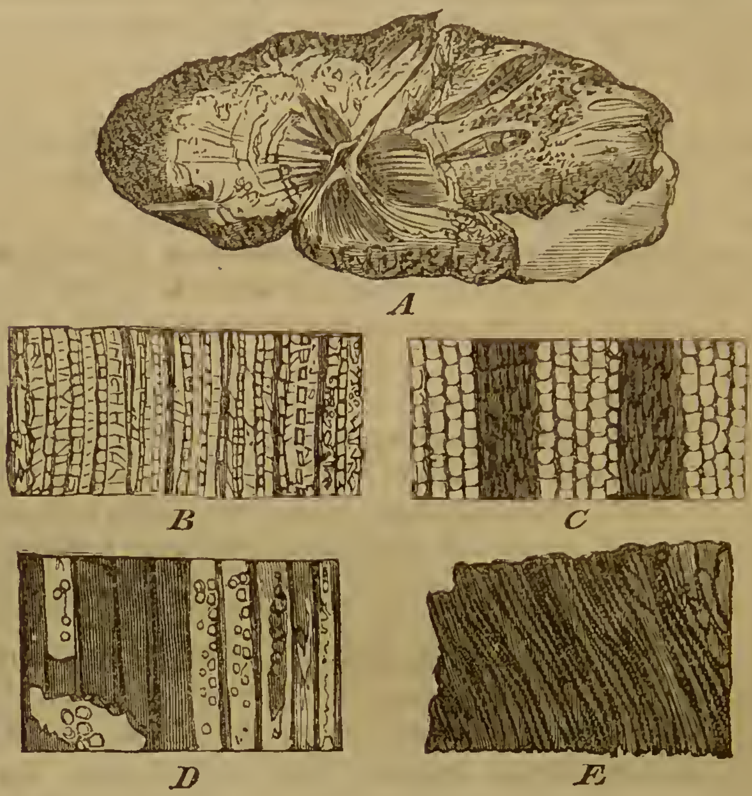
(1468.) The extensive range of the Pineales, and the vicarious presence of the order by equivalent genera and species in both hemispheres, would seem to bespeak its importance; and, next to those which afford his staple food, there is none that is more universally and immediately serviceable to man. On a rough calculation perhaps four-fifths of the timber used in domestic architecture is derived from these plants, and they likewise afford a large proportion of that now employed in ship and boat building, and in the construction of household furniture. The tractability of most, and the extreme durability of many of the pineal woods, fit them for numerous works of art, and recommend them strongly to general favor. As a source of revenue it is not unimportant, for the duties paid on pine timber alone brought into our ports from foreign parts, amounts to nearly a million and a half per annum.

(1469.) As dietetic plants the Pineales do not hold a very exalted rank; for, although the seeds of many are eatable, and the fruit and leaves of a few are not to be despised, as food, and although in barren countries the bark of some is made into bread, still these are uses which, great as may be their value in peculiar situations, are on the whole of secondary importance; but the secretions of the pines are valuable indeed, both as medicines and in the arts, as the immense consumption of their various balsams, resins, turpentines, and tars, and the innumerable purposes to which they are applied, sufficiently declare.

GEOLOGICAL DISTRIBUTION OF THE PINARES.

(1470.) Since, by the labours of Witham, the intimate structures and textures of fossil plants have been disclosed, and his mechanical contrivances have enabled the botanist to examine and note their anatomical peculiarities with almost as much facility as in the case of recent vegetables, the affinities of many ambiguous

relics have been made out, their differences and identity established, and sometimes even their degree of approximation to existing species satisfactorily shewn;



A. Lennel Braes-tree, *Pitus antiqua*. Transverse section, containing vestiges of organic structure, although in part disorganized, and spaces filled by crystals of extraneous matter. The centre consists of calcareous spar, and the lighter rays proceeding from it of the same; certain organic portions also radiate from the centre, and are lost in the apparently cellular masses of the circumference. The seeming cellular external mass is not organic, but consist of crystals of calcareous spar; in it, however, are organic portions that run lengthwise, continuously, through the mass.

B. Part of one of the organic relics highly magnified, to shew its regular woody texture and medullary rays.

C. Transverse section of the Tweedmill fossil-tree, *Pitus primæva*, shewing its very broad medullary rays.

D. Coal, from the Northumberland limestone series, shewing elongated cellules in a longitudinal section parallel to the medullary rays.

E. Fragment of Bovey coal, which, from its distinctly stratified texture, is indisputably the remains of an exogenous plant, and probably of one of the Pineales, and named by Witham, *Pinites carbonaceus*.

and this by means as simple and unhoped for, as the evidence afforded is conclusive and direct.*

* His method of preparing fossil plants for microscopic observation is thus briefly described by Mr. Witham: "A thin slice is first cut from the fossil wood, in a direction parallel or perpendicular to the fibres. It is ground flat and polished on one side, which is attached by means of Canada-balsam to a piece of plate-glass, after which it is ground down to the necessary degree of thinness, and polished. By this means the internal structure may frequently be as distinctly seen as in the slice of the recent vegetable."

(1471.) On the former history of no class have the researches of Witham and his coadjutors thrown more important light than on the present, and valuable accessions are being daily made to our knowledge of the ancient allies and representatives of the *Pinares*.

(1472.) Five years have scarcely yet elapsed since the highest authority in this department of natural science expressed something more than a doubt of the existence of coniferous plants in the coal era, whereas it is now proved beyond cavil that representatives of such plants not only did exist, but that they formed an essential and prominent feature in the vegetation of the epoch referred to; and this change of doctrine has been wrought not more by the discovery of new fossils than by a better acquaintance with the old.

(1473.) Representatives of both the *Pineales* and *Zamiales* are found in a fossil state, and not only representatives of these two at present existing orders of the *Pinares* have been discovered, but indications of other allied groups, probably now extinct, which appear to have been transitional between the *Firs* and *Ferns*, and to have associated more closely than recent examples do, these two essentially diverse and yet curiously similar classes.

(1474.) Both the existing genera, *Zamia* and *Cycas*, have representatives in a fossil state. Of the former sixteen species have been discovered, twelve of which are so like to those at present existing, that they are included in the same genus, and enjoy the same denomination as the recent plants. The remaining four, although closely allied, differ in the exsertion and venation of their leaves, and hence their affinity and diffinity are marked by their derivative generic name, *Zamites*. Of these sixteen species fifteen have been found in the Lias and Oolitic formations; the precise locality of the sixteenth, *Z. Buchanani*, brought from the East Indies, is unknown.

(1475.) Some fossil leaves discovered in the lower chalk-beds in Sweden so strongly resemble the modern cycases, that Brongniart has formed a genus for their reception called *Cycadites*, and the only species as yet known he terms *Nilsoniana*, in honour of the finder.

(1476.) Two fossil stems resembling those of Zamia have been found in the Portland-stone. Dr. Buckland, who described and figured them in the Transactions of the Geological Society of London, proposed to call them *Cycadeöideæ*; but, as they rather resemble Zamiæ than Cycades, Brongniart has changed the name to *Mantellia*, dedicating them to our well-deserving countryman Gideon Mantel. He also includes in the same genus another stem found in the shelly limestone near Luneville, and which, as it appears to resemble *Cycas* as much as the other do *Zamia*, had perhaps better assume their discarded name, *Cycadeöidea*.

(1477.) Besides these immediate allies, other fossil remains have been discovered, which, although not so closely similar to the at present existing Zamiales as the foregoing, are still evidently referrible to this group. These occur in the lower Oolitic beds and in the variegated marl and sandstóne of the Lias. Eight of these species are included in a genus called *Pterophyllum*, and the remaining two in another termed *Nilsonia*. The gyrate vernation peculiar to the *Ferns* and *Cycadaceæ*, is very evident in the fragments of the two last named genera.

(1478.) Of the Pineales the vestiges are more abundant than of the preceding order, representatives having been already found of the *Yew*, *Ginkgo*, and *Podocarpus*; *Cypress*, *Juniper*, and *Thuja*; *Pinus*, *Abies*, and *Araucaria*, as well as

other less closely associated genera at present perhaps extinct, such as *Peuce, Pinites,* and *Pitus,* with the questionable *Brachyophyllum* and debateable *Lepidodendra.*

A. Craigleith fossil-tree of 1830, (Pinites Withami,) forty-seven feet long, and diameter at the base five feet by two feet, and at the broken off small end one foot seven inches by one foot four inches. B. Araucaria perigrina, (*L.* and *H.* 88.) C. Sphenophyllum erosum. D. Sphenophyllum Schlotheimii. (*a*) Leaf of Salisburia, to shew its resemblance to the fossils.

(1479.) Five species of fossil plants occur in the tertiary beds and one in the Oolites, which so strongly resemble the yew that they have been called *Taxites;* and a curious fossil has been found at Aix, in the fresh-water beds of the tertiary series, that has been referred to the genus *Podocarpus.*

(1480.) The affinities of the eight species of *Sphenophyllum,* discovered in the coal series, are not so unquestionable. Brongniart associated them with the *ferns,* likening them to the *Marsiliaceæ,* but he was probably misled in his judgment by the then current doctrine that the Pineales were not to be found in the carboniferous strata, in which ferns were known to be abundant; and the authors of the Fossil Flora with much more apparent justice refer these fossils to the vicinity of *Salisburia,* one of the *Taxinæ,* [§ 1478, C, D, *a.*]

(1481.) The primæval Cupressinæ already known are, first, the doubtful *Brachyophyllum mammillare* found in the lower Oolite, three species of *Juniperites* in the tertiary strata, one species of *Cupressites* in the new red sandstone, three or four species of *Thujites* in the Jura schist, and several species of *Thuja,* not generically differing from the present existing plants, amongst the lignites of the tertiary series.

(1482.) The prototypes of the section *Abietinæ* are the following. The *Voltziæ*, of which four species have been found in the new red sandstone: these fossils are likened by Brongniart to the southern *Araucariæ*. One species of *Abies* called *Laricioides;* nine species of *Pinus*, among the lignites, and in the different strata of the tertiary series; and several species of *Peuce*, *Pinites*, and *Pitus*, in the Lias, Oolite, and the coal formations; the latter two being genera structurally different from any known existing plants, although clearly allies of the *Abietinæ*. These fossil *Pineales*, as Mr. Witham observes, "evidently pass into each other by a regular gradation, and therefore in all probability belong to the same natural family. *Peuce* is obviously a conifera, and the others differ only in circumstances which do not seem very important. Thus *Peuce* has the woody tissue very distinctly divided by concentric circles, while in the other genera these circles are occasionally present, but more frequently absent. In *Peuce* the pith is not larger than in our recent coniferæ, but in *Pinites* it is at least four times the size. The walls of the woody tissue of our recent *pines* are marked with single series of separated areolæ, seldom occupying their whole breadth; those of *Peuce* are also marked with single series of precisely similar areolæ, but some of them have also double series. In *Pitus* the areolæ are always in double or triple series, although still separate, and usually roundish. In *Pinites* the areolæ are hexagonal, contiguous, and arranged in two or more series."

(1483.) A curious fossil found in the mountain limestone series, at Allenbank, in Berwickshire, and called by Mr. Witham *Anabathra pulcherrima*, from the extreme regularity and beauty of its ladder-like cellular structure, has, according to its discoverer, some resemblance to our recent Coniferæ; but he does not venture absolutely to decide on its relationship. That it is an exogenous plant appears evident from its having "a regular pith," and that it is associable with the *Pineales* rather than with any other order seems probable from "the tissue between the pith and the surface, which is composed of elongated cellules, or woody fibres, remarkable for their extreme regularity, being disposed *precisely like those of our recent* Coniferæ, but without indications of concentric circles." This opinion is further corroborated by the medullary rays which are present being "extremely sparse, and remarkable for their small size." On a transverse section they present an elliptical form, and the walls of the elongated cellules are marked all round with very regular, close, horizontal lines.

(1484.) The similarity of the *Lycopodiaceous ferns* with certain tropical *Pineales*, such as *Araucaria excelsa*, the Norfolk-Island pine, and others, and especially of the gigantic fossil *Lycopodites*, and *Lepidodendra*, has been often dwelt on; and Brongniart, when denying the presence of the Pineales in the coal formation, qualifies the denial by referring to these fossils as the most likely of any to furnish exceptions to his rule, (Prod. p. 175.) This half-prophetic hint has but lately been shewn to have been not an idle speculation: it is true that other coniferous plants had been previously shewn to be abundant in the carboniferous strata, and that the Lepidodendra have not been absolutely proved to belong to the order Pineales; but the anatomical structure of one species, viz. *L. Harcourtii*, which has been examined by Mr. Witham, and subsequently by Messrs. Lindley and Hutton, demonstrates that it at least, if not other Lepidodendra, approaches very closely in its internal organization to the pines; and whether it be proved to be a flowering or a flowerless plant, it will equally be-

come a further band of union, and connect the two classes, firs and ferns, still more closely. Witham, in his treatise on fossil vegetables, inclines to its arrangement with the Lycopodiaceous ferns, but the authors of the Fossil Flora seem to believe it more nearly related to the pines. The twofold affinities of this interesting fragment have been well described and discussed in both the works referred to, in the latter of which the following summary is given: "It had a central pith, it had a vascular sheath surrounding that pith, and it had fistular passages in its cortical integument; thus far it was coniferous. But no trace can be found of glandular woody fibre; it can scarcely be said to have had any wood, and it is uncertain whether it had bark." "Its vascular system was confined to the middle of the stem, and to the curved passages emanating from it; the stem consisted chiefly of lax cellular tissue, which became more compact towards the outside, and it had a very powerful communication between the bases of its leaves and the central vascular system; thus far it was Lycopodiaceous. But recent plants of the latter tribe have no fistular cavities in their cortical integument, a point of great importance, because such cavities indicate the presence of resinous or other secretions which are never found in *Lycopodiaceæ;* and secondly, the latter have no vascular sheath surrounding pith, which, if not an absolute sign of exogenous structure, is a very near approach to it."

(1485.) Such are the chief plants associable with the *Pinares,* vestiges of which have been found in a fossil state, and their epochs of existence reach from the coal to the upper tertiary formations, an extent of duration only of late conceded to this class. It now seems strange, the fact of their primæval existence being established, that the discovery was not made before, or at least, the chemical constituents of coal being known, their similarity with the products of the *Pines,* and their utter dissimilarity from those of the *Ferns,* being equally notorious, it does seem strange that the production of coal should have been almost exclusively attributed to ferns, and their allies, while the resinous Pineales were believed to be wholly absent from the beds of this bituminous fossil. For, although ferns occur in immense abundance in certain beds, as in those of Newcastle, Durham, and Yorkshire, still, when it was found in others, as in those of the Edinburgh and Lothian basins, consisting of thirty-three seams, the impressions of ferns are so rare as to be reckoned curiosities, it does seem strange that, while the impressions and remains of vascular cryptogamic plants were revealing the history of their former existence, so many magnificent members of the Phanerogamic classes should, as Witham well observes, have been allowed to lie speechless in their early graves, instead of proclaiming the antiquity of their origin and the usefulness of their order. But they are speechless now no longer; their graves have yielded up the dead; science has reanimated each lifeless corse, and given tongues to these once dumb mouths, which tell to the astonished and half-disbelieving world many a tale of wonder.

(1486.) From the preceding data it will be evident that the epochal, or as it were statistical, distribution of the fossil Pinares, is strictly coincident with that of the other classes, and hence it is to be presumed that the general laws which regulated the disposition of the one likewise influenced the geological relations of the others.

(1487.) Thus the fossil remains of *Thuja, Pinus,* and *Podocarpus,* are all confined to the tertiary strata. The *Juniperites,* and five species of *Taxites,* also

belong to the same series; while *Cupressites*, the tropical *Zamiæ*, and *Voltzia*, the representative of *Araucaria*, are the fossils of the secondary beds. The extinct species, the furthest removed from recent plants in their structure, are in general also the furthest from them in their geological position. For example, the *Cycadites* occur in the chalk, the *Mantelliæ*, in the Portland stone, the *Nilsoniæ*, and *Pterophylla*, in the marl and limestone of the Lias, and the lower Oolitic beds. *Peuce*, the most like of the extinct *Abietinæ* to existing species, is found in the Lias and Oolite only, *Pitus antiqua* and *primæva* in the mountain limestone, *Pinites* in the mountain limestone and the coal seams, and the ambiguous *Sphenophyllum* in the coal formation likewise.

(1488.) But not only are the nearest fossil allies of recent plants found in the more recent series, and their more remote associates in the older strata, but the analogies when traceable, are chiefly to existing tropical species, as *Zamia*, *Cycadites*, *Mantellia*, &c. to the *Zamiales*; the *Voltziæ* of our British red sandstone to the *Araucariæ* of the southern hemisphere; and so forth.

(1489.) Even the development of the stem yields other curious food for speculation. It is well known that, in the exogenous trees of warm countries the concentric strata are not so decidedly marked as in the timbers of cooler climes, and often, as in the mahogany and other equinoctial woods, the annual growths are undistinguishable, and the well-defined laminated circles are wanting altogether. Again: it is equally well known that the plants of hot moist regions, such as the swamps of tropical America, are not only very rapid in their growth, but their cellular structure is usually much developed, the cells large, and the texture loose. Even in temperate latitudes warm damp summers favor the growth of wood, and in such seasons broader annual layers are produced than in cold and dry ones.

(1490.) These are circumstances which have not escaped the acute and observant Witham. He notices that "the cells of the fossil coniferæ are generally much larger than those of our present trees of the same family." That in them, especially in the most ancient fossils, the pith is voluminous, and the medullary rays often composed of three, four, or five series of cellules, while in the existing species the plates are thin and the pith exceedingly small.

(1491.) Again, the concentric layers of many fossil vegetables exhibit "the same irregularities as those of our present trees, some of them being much broader than others. An inference to be drawn from this circumstance is, that the climate which existed at the epochs when these vegetables grew, resembled ours in the irregularity of its successive summers. If at the present day a warm and moist summer produces a broader annual layer of wood than a cold or dry one, and if fossil plants exhibit such appearances as we refer in recent vegetables to a diversity of summers, then it is reasonable to suppose that a similar diversity formerly prevailed. The remark, however, continues Witham, applies only to the plants of the Lias and Oolite, and the eras in which they flourished. For the *coniferæ* of the coal formation and mountain limestone group have few and slight appearances of the lines by which annual layers are separated; which, as already stated, is also frequently the case with the trees of our present tropical regions. "It is therefore possible that at the epochs of these formations the changes of seasons, as to temperature at least, were not abrupt;" and it is more than probable, other

circumstances considered, that the average temperature was high, the reduction rarely if ever great, and the atmosphere burdened with aqueous vapours.

(1492.) The barren rocks and proverbially sterile soil on which many of the Pineales alone will flourish, and the swampy districts in which others the most abound, are circumstances well deserving attention. The dismal swamps of America are overrun with cypress and fir, the rocks and hills of Europe and of Asia are crowned with gloomy forests of pines. On the sandy plains, the chalky downs, and even in the slaty trap and the granite districts, from the equator almost to the poles, Juniper will flourish, where nothing else will grow. Such plants, it is evident, do not draw greatly for sustenance on the soil. They were therefore well fitted to form a prominent part of the flora of those epochs in which vegetable mould was scarce, when the surface of the globe consisted chiefly of barren emerging rocks and extensive swamps. Such plants as these were fit fellow-labourers with the ferns to withdraw the superabundant carbon from the air, and to convert the aërial poison into wood, turpentine, and resin, whence that bituminous mineral called coal has been derived.

The growth and destruction of pine forests, the formation of peat, and the conversion of vegetable matter into lignite, jet, and coal; the separation of the coke from the Asphaltum, the Naphtha, and the various kinds of bitumen and mineral tar; with the application of these numerous products and educts in the arts, are paragraphs in one of those wonderful chapters in the history of the world which man is but beginning to translate.